FEB 27 1928

The Engineer.

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VOL. CXLV.—No. 3761] LONDON: FRIDAY EVENING, FEBRUARY 10, 1928 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
3 FOUR-WHEELED POWDER VANS, 5ft. 6in. gauge.
Tenders due on the 5th March.
Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each schedule. 7758

Assistant Engineers (6) REQUIRED by the GOVERNMENT of KENYA for the PUBLIC WORKS DEPARTMENT, for a tour of 20-30 months' service. Salary £480, rising by annual increments to £840 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, age 25-40, unmarried, must be Corporate Members of the Institution of Civil Engineers or hold an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the A.M.I.C.E. Examination, and have had general experience in Civil Engineering Works, especially Buildings and Roads.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/428. 7737

Assistant Land Officer and SURVEYOR REQUIRED by the GOVERNMENT of the GAMBIA for two tours of not less than twelve nor more than eighteen months' service, with prospect of permanency. Salary £450 a year for the first three years of service, then £480, rising to £600 a year by annual increments of £30. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, age 25-35, must be fully qualified Land Surveyors and have some knowledge of deeds relating to land and valuation of property and some colonial experience of Land Surveying.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/423. 7685

Civil Service Commission.
FORTHCOMING EXAMINATION: MALE CARTOGRAPHERS in the Hydrographic Department of the Admiralty (19-25, with extension in certain cases). Regulations and particulars are obtainable from the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1, together with the form on which application must be made. The latest date for the receipt of application forms is 24th May. 7688

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
7059 Newcastle-upon-Tyne.

THE SIR JOHN CASS TECHNICAL INSTITUTE,
Jewry Street, Aldgate, E.C. 3.

Course of Six Lectures on Thursday evenings at 7 p.m., commencing February 23rd.

FUEL TECHNOLOGY.
BOILER FUELS AND BOILER ECONOMY.

LIQUID FUEL.
Eng.-Rear-Admiral A. E. HYNE, C.M.G. (Retd.).
GASEOUS FUEL.
W. A. TOOKEY, M.I.Mech.E., M.I.A.E.
SOLID AND POWDERED FUEL.
B. SAMUELS, M.I.Mech.E.
MODERN PLANT AND WORKING.
W. H. PATCHELL, Past. Pres. Inst. Mech. E.
Fee for the full Course . . . 20s.
Syllabus on application to GEO. PATCHIN, Principal.
Stations:—Aldgate (Met.), Mark Lane.
Bus Routes:—5, 10, 15, 23, 25, 40, 42, 78, 96, 125.

The Institution of Chemical ENGINEERS.
EXAMINATIONS, 1928.
Application forms (returnable 12th March, 1928) and particulars of the Associate-Membership Examinations for 1928, together with the Memorandum on "The Training of a Chemical Engineer," may be obtained from the Hon. Registrar, C. S. GARLAND, Esq., Institution of Chemical Engineers, Abbey House, Westminster, London, S.W. 1. 7488

The Engineer

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PUBLIC NOTICES

Administrative County of LONDON.
REMOVAL OF SEWER DEPOSIT.
The London County Council invites TENDERS for the REMOVAL and DISPOSAL of SEWER DEPOSIT and other MATERIALS in connection with the main drainage, &c., services for four districts—two north of the Thames and two south of the Thames, east and west respectively—for a contract for twelve months, commencing 1st April, 1928.
The specification, form of Tender, &c., may be obtained on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £1 by cheque or draft to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before the payment of the fee.
Correspondence and remittances by post should be addressed to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, or if personal application is made applicants should apply in Room 3A at No. 3, Warwick House-street, Cockspur-street, S.W. 1.
The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 20th February, 1928, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
MONTAGU H. COX,
7701 Clerk of the London County Council.

Bombay, Baroda and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Wednesday, 29th February, TENDERS for the SUPPLY of :—
1. COPPER FIRE-BOX PLATES.
2. FLANGED STEEL BOILER PLATES.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of £1 each for No. 1 and 10s. each for No. 2 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices: 91, Petty France, Westminster, S.W. 1,
9th February, 1928. 7731

PUBLIC NOTICES

Tenders are Invited by the MINISTRY of PUBLIC WORKS, Egyptian Government, for the SUPPLY and ERECTION at Mex Pumping Station of TWO DIESEL PUMPING UNITS and ACCESSORIES, including TWO DIESEL ELECTRIC GENERATING AUXILIARY SETS. Engines to be of the Open (not box frame) Four-stroke Cycle Type.
Tenders will be received in Cairo up to Noon on 14th April, 1928.
Conditions of Tender and specification are available for scrutiny at the office of the CHIEF INSPECTING ENGINEER, Egyptian Government, 41, Tothill-street, S.W. 1, and may be purchased against remittance of 21s. per set, which money is not returnable. 7681

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—
220,000 LEFT-HANDED 10 INCHES STEEL SLEEPER KEYS to suit B.S. 60-R. F.F. Rails (approximate total weight equals 133 Tons).
Tenders are due in on Tuesday, 28th February, 1928, by 2 p.m. Tender form obtainable at above address; fee One Guinea, which is not returnable.
The Directors do not bind themselves to accept the lowest or any Tender. 7703

MACHINERY FOR SALE.
The Lurgan Urban District Council are prepared to receive OFFERS for the following MACHINERY, which is in perfect mechanical order :—
LANCASHIRE BOILER, with Galloway tubes, 24ft. by 7ft., made by John Cochrane, Barrhead, Glasgow, in 1893. Insured for 90 lb. square inch.
HORIZONTAL COMPOUND CONDENSING STEAM ENGINE, diameter of cylinders 15in. and 27in., stroke 2ft. 6in., I.H.P. 60, tandem coupled, two double-acting multi-valve pumps, rams 8in. diameter.
HIGH-SPEED VERTICAL STEAM ENGINE, 9in. bore, stroke 8in., I.H.P. 13, direct coupled to 3ft. CENTRIFUGAL PUMP with central suction and 8in. discharge.
32-Tube SET of GREEN'S ECONOMISER, installed Nov., 1915.
DOUBLE-ACTING WORTHINGTON DUPLEX STEAM PUMP, size 4½in. by 2½in. by 4in.
J. W. POLLOCK,
Town Clerk.
Lurgan, N.I. 7717

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Notice is Hereby Given that SPENCER-BONECOURT, Limited, a British Company, of Broadway Buildings, 50, 64, Broadway, Westminster, London, S.W. 1, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 140,851, granted to Percy St. George Kirke for an invention entitled "Improvements in Waste Heat Boilers."
Particulars of the proposed Amendment were set forth in the Illustrated Official Journal (Patents) of the 1st February, 1928.
Any person or persons may give Notice of Opposition to the Amendment by leaving Patents Form No. 15 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. S. JARRATT,
7691 Comptroller-General.

Borough of Guildford.
(WATERWORKS EXTENSIONS UNDER GUILDFORD CORPORATION ACT, 1926.)
CONTRACT NO. 5.
ELECTRICALLY DRIVEN PUMPING PLANT AND ACCESSORIES.
The Corporation of Guildford are prepared to receive from manufacturers of Turbine Pumps offers to TENDER for (A) THREE SETS of BORE-HOLE PUMPS, SURFACE PUMPS and ELECTRICAL EQUIPMENT, each capable of raising 60,000 gallons of water per hour from a depth of 115ft. below the surface to a height of 288ft. above the surface including friction in delivery main); (B) DUPLICATE SETS of BOOSTER PUMPS and ELECTRICAL EQUIPMENT, each capable of delivering 45,000 gallons of water per hour under a maximum differential head of 58ft.; and (C) DUPLICATE SETS of CENTRIFUGAL PUMPS and ELECTRICAL EQUIPMENT, each capable of delivering 12,000 gallons of water per hour under a head of 150ft. (including friction in delivery main) and automatic control for same from water level in reservoir.
Contractors willing to Tender are requested to forward their offer with particulars as to their resources and experience to the Consulting Engineer, Mr. Percy Griffith, M. Inst. C.E., F.G.S., 39, Victoria-street, Westminster, S.W. 1, not later than Friday, the 17th day of February next.
Copies of the specification, drawings and other necessary documents will be supplied to a limited number of selected firms with particulars as to the date when Tenders must be delivered as soon as possible after the date above mentioned.
The Corporation do not bind themselves to accept the lowest or any Tender.
C. H. WOOD,
Town Clerk.
Town Clerk's Office, Guildford,
February 10th, 1928. 7671

West Ham Union.
TO LAUNDRY ENGINEERS.
The Guardians invite TENDERS for the SUPPLY and FIXING of ONE ROTARY WASHING MACHINE for their Hospital, Whipps Cross-road, Leytonstone, E. 11.
Persons and firms desirous of tendering should forward their names and addresses to the undersigned, when a copy of the specification of the machine required will be furnished.
Tenders must be delivered to the undersigned not later than Thursday, the 23rd February, 1928.
L. E. FRAQUET,
Clerk to the Guardians.
Board Room:
Union-road, Leytonstone, E. 11,
8th February, 1928. 7739

Borough of Guildford.
WATERWORKS EXTENSIONS.
CLERK OF WORKS AT NEW PUMPING STATIONS.
The Corporation invite APPLICATIONS for the APPOINTMENT of CLERK OF WORKS in connection with the Erection of Pump-house, Manager's Residence, Centrifugal Pumping Plant, and Electric Motors at the Joseph's-road Pumping Station and an Installation of Pumping Plant at the Pewley Hill Reservoir Site, both in the Borough of Guildford.
Applications, stating the age of the candidate and his experience in regard to (a) building work and (b) electrically driven pumping plant, accompanied by copies of three recent testimonials, should be sent by post to the Consulting Engineer, Mr. Percy Griffith, M. Inst. C.E., F.G.S., 39, Victoria-street, Westminster, S.W. 1, not later than the 17th of February next.
The appointment will be from such date as the contracts may be let and for the period required for the completion of the works or for such shorter period as the Corporation may determine.
Salary £6 6s. per week.
C. H. WOOD,
Town Clerk.
Town Clerk's Office, Guildford,
February 10th, 1928. 7672

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PUBLIC NOTICES

Applications are Invited (by letter only) from properly qualified candidates as

TRANSMISSION LINE ENGINEER,

who must be thoroughly qualified in reconnaissance work, control of survey and construction of high-tension overhead transmission lines. Age about 30 to 35 years, unmarried man preferred. Salary £800 to £900 per annum, according to age and qualifications. First-class free passage to Malaya and home again on satisfactory termination of services. The selected candidate will be required to pass a strict medical examination before appointment. Applicants must give particulars of their general and technical education and a detailed record of their practical training and subsequent experience with dates in each case, names of employers from time to time and the class of work carried out, together with copies only of testimonials, which cannot be returned. Letters should be addressed to the undersigned not later than 21st February, 1928.

RENDEL, PALMER & TRITTON,
Appointments Department,
7718 13, Dartmouth-street, Westminster, S.W. 1.

Mersey Docks and Harbour BOARD.
ENGINEER-IN-CHIEF.

The Mersey Docks and Harbour Board invite APPLICATIONS for the POSITION of ENGINEER-IN-CHIEF to the Board, which will be vacant at the end of June.

Candidates, who should be under 50 years of age, must be Members of the Institution of Civil Engineers and have had good experience in Dock and Harbour Construction and Maintenance and also in Estuary and River Training Works.

Applications, stating salary required, age, qualifications and experience, accompanied by copies of not more than three recent testimonials, to be sent to the undersigned not later than March 31st, 1928.

L. A. P. WARNER,
General Manager and Secretary.
Dock Office, Liverpool,
January 9th, 1928. 7454

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, Experienced Skilled ERECTOR. Accustomed to erection of complete Water-tube Boiler Plant, Steel Work, &c. Must be able to take complete charge. Only first-class men need apply. State experience and salary required.—JOHN THOMPSON WATER TUBE BOILERS, Ltd., Wolverhampton. 7690 A

WANTED, MAN to Take Charge Preparation of Advertisements, Catalogues, and Publicity Literature for Specialist Engineering Firm, preferably with technical training and publicity experience. Good position suitable man.—Address, "PUBLICITY," William Porteous and Co., Advertising Agents, Glasgow. P4125 A

ASSISTANT ENGINEER REQUIRED for Engineering Department (Power-house Plants) at our Baden Works. Applicants must possess engineering degree or first-class diploma and practical experience in works and steam turbine power-house and/or on turbine test beds. Age 25-30.—Full particulars to SECRETARY, Brown Boveri and Company, Baden-Aargau, Switzerland. 7553 A

ASSISTANT to CHIEF ENGINEER REQUIRED by Manufacturing Works in North Manchester district. Under 30 years of age. Knowledge of Civil and Mechanical Engineering desirable. State age, qualifications, experience, and salary required.—Address, 7715, The Engineer Office. 7715 A

ELECTRICAL and MECHANICAL ENGINEER REQUIRED for South Africa, with Mining experience and knowledge of Diesel Engines. Must hold Union of South Africa Engineer's Certificate endorsed for Mining Machinery. State salary required.—Write to "L. Q.," c/o Street's, 6, Gracechurch-street, E.C. 3. 7711 A

ELECTRICAL and MECHANICAL ENGINEERS.—Opportunity occurs for an energetic and ambitious young man, good engineering experience and able to undertake the Electrical and Mechanical Design of A.C. Motors on a commercial basis. Good prospects to man with the right qualifications.—Address, stating age, experience, and salary expected, along with copies of testimonials, 7713, The Engineer Office. 7713 A

ENGINEER ASSISTANT WANTED for a Tea Garden in Northern India. Must be educated at a public school, single, between 21 and 23, and fully qualified mechanical engineer with experience of I.C. Engines and Electricity. Salary Rupees 325 per mensem and first-class passage.—Write, with full particulars, to B. R., c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 7696 A

ENGINEER MANAGER WANTED for Shipbuilding and Engineering Works in Hong Kong, with good general and technical knowledge; must have had previous experience in Management of Marine Engine Works; age 32-35. State experience in full and send copy testimonials.—Address, 7547, The Engineer Office. 7547 A

ENGINEER (MECHANICAL) REQUIRED, to Take Charge of all Plant and Machinery other than Electrical at large modern Steel Tube Works. Must be fully experienced in the economical running and maintenance of Steam, Hydraulic, and Pneumatic Power Installations, Rolling Mills, Large and Small Machine Tools, Steam Locomotives, and all General Engineering matters. Capable of supervising engineering foremen and skilled workmen. Only thoroughly capable and experienced men need apply with full particulars of training, past experience, and salary expected.—Address, 7724, The Engineer Office. 7724 A

ENGINEER SALESMAN REQUIRED, Resident London, for Centrifugal Oil Purifiers; must be expert salesman with technical knowledge essential. Salary and commission.—Address, 7662, The Engineer Office. 7662 A

HIGH-CLASS SUPERINTENDENT and FOREMAN REQUIRED, used to Machine Tools and Bench Work on Large Dies for Automobile Bodies. Give fullest details and salary required.—Address, 7695, The Engineer Office. 7695 A

SYNTHETIC AMMONIA and NITRATES, Ltd. (Associated with Imperial Chemical Industries, Ltd.) REQUIRE the SERVICES of MECHANICAL ENGINEERS, age 25-32. Applicants must possess first-class practical experience, and must have had University or similar technical training. Previous experience on Machine Design and Lay-out Work essential.

The work to be undertaken is the design of works plant.

Duties will commence in the drawing-office, but promotion and salary will be entirely dependent upon ability and personality.

Replies to be addressed to the CHIEF ENGINEER, Synthetic Ammonia and Nitrates, Ltd., Billingham, Stockton-on-Tees. 7719 A

WANTED, LIFT DRAUGHTSMAN by Firm in the Midlands.—Address, stating age, experience, and wages required, 7645, The Engineer Office. 7645 A

DRAUGHTSMEN.—Capable MEN REQUIRED, with thorough knowledge of up-to-date Steam Turbines.—Apply, stating age, experience, and salary required, to FRASER and CHALMERS ENGINEERING WORKS, Erith. 7705 A

DRAUGHTSMAN, First-class Structural Detailer, REQUIRED. Give full particulars, experience. Good salary given to right man.—Address, 7697, The Engineer Office. 7697 A

DRAUGHTSMAN, for Midland Works, with Good General Electric Control Gear and A.C. and D.C. Contactors experience. State age, experience, and salary required.—Address, 7601, The Engineer Office. 7601 A

DRAUGHTSMAN, Mechanical Electrical, for Midland Works, Senior, over 26 years of age. Must have good experience of Electric Traction Motors.—Address, stating age, experience, and salary required, 7699, The Engineer Office. 7699 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED; Must be Fully qualified, experience in Steel Structures with Machinery essential.—Address, stating age, experience and salary, 7726, The Engineer Office. 7726 A

DRAUGHTSMEN REQUIRED, Having Experience in Elevating and Conveying Machinery.—Address, stating age, experience, and salary, 7727, The Engineer Office. 7727 A

DRAUGHTSMAN REQUIRED, to Lay Out Production Drawings in Works employing about 700 hands, making very accurate machinery. Progressive position for a young man with plenty of energy. Only those who have had workshop experience will be considered.—Address, stating age, experience, and salary required, 7694, The Engineer Office. 7694 A

DRAUGHTSMAN REQUIRED, with Good Experience in Structural Steelwork, for works in London.—Address, stating age, experience and salary required, 7735, The Engineer Office. 7735 A

DRAUGHTSMAN, Senior, Having Sound Experience of Electric Controllers, Auto Starters, and Contactor Type Control Gear.—Address, stating age, experience, and salary required, 7600, The Engineer Office. 7600 A

DRAUGHTSMAN (Senior) REQUIRED by the LANCASHIRE DYNAMO and MOTOR CO., Ltd., Trafford Park, Manchester, for A.C. and D.C. Machinery. Must be reliable and have had first-class experience. 7709 A

DRAUGHTSMAN WANTED, Experienced in Structural and Mechanical Work in connection with Coal-handling Plants. Experienced men only need apply. State age, experience, and salary required.—Address, 7729, The Engineer Office. 7729 A

DRAUGHTSMAN WANTED, with Sound Engineering experience, able to work out own calculations. State age and wage required.—Address, 7732, The Engineer Office. 7732 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine design and detail work, for works in Midlands. State age, salary, experience, and when able to commence.—Address, 7658, The Engineer Office. 7658 A

EXPERIENCED DRAUGHTSMEN REQUIRED. Applicants must be experienced in General Engineering Work, Chemical Plant Design and Lay-out, Steel Structural Work, Driving Arrangements, &c. Reply, stating age, experience, and salary required, to BRITISH DYESTUFFS CORPORATION, Ltd., P.O. Box A.38, Huddersfield, and endorse envelope "Draughtsman." 7698 A

LOCOMOTIVE DRAUGHTSMAN, with Experience in Light Railway Material preferred. State age, experience and salary.—W. G. BAGNALL, Ltd., Castle Engine Works, Stafford. 7733 A

WANTED, First-class CONSTRUCTION FOREMAN ENGINEER, to supervise erection of new plant.—Address, stating experience, &c., to Ref. J.Y.D., 7723, The Engineer Office. 7723 A

PLATER REQUIRED, with All-round Experience, for Steel-framed Constructional Work.—Address, 7728, The Engineer Office. 7728 A

REQUIRED, ENGINEERS' FITTER; Must be a well-experienced engineer, accustomed to General Repair Shop, able to take any class of work. Also TURNER and FITTER IMPROVER REQUIRED.—CONSTABLE, OHLSON and BROAD, Electrical and Mechanical Engineers, 16, Surrey-lane, Battersea, S.W. 11. P4131 A

SITUATIONS WANTED

A.M.I.C.E., A.M.I. Mech. E. (37), with Railway locomotive, works, D.O., running sheds, automobile, tramway, general mechanical and maintenance work, building and public works and some electrical and commercial experience, wide and successful experience control of large staffs, DESIRES CHANGE.—Address, P4115, The Engineer Office. P4115 B

CIVIL ENGINEER (32), A.M. Inst. C.E., A.M.I. Struct. E., DESIRES to CHANGE present APPOINTMENT for one of more activity. Broad training university and consultant's office. Experience mainly bridge and structural work.—Address, P4099, The Engineer Office. P4099 B

CONSTRUCTIONAL STEEL WORKS FOREMAN REQUIRES SITUATION as Foreman or Works Manager. Age 35 years, experienced in all classes of steel work, heavy bridgework, hydraulic presses, general smith work, &c. Keen estimator and rate fixer; 4 years similar position.—Address, P4132, The Engineer Office. P4132 B

ENGINEER, General Maintenance, 18 Years' Sea experience, 1st class B.O.T.; experience water-tube boilers; London or South preferred.—Address, P4139, The Engineer Office. P4139 B

ENGINEER, M.I. Mech. E., with Long Sales and technical experience, WISHES to HEAR from first-class FIRM REQUIRING REPRESENTATION in London and the Home Counties. Would take over London office.—Address, P4127, The Engineer Office. P4127 B

ENGINEER (23) DESIRES POSITION, Any Capacity; 7 years' aeronautical experience, shops, drawing-office, and technical. Excellent references.—"Combemartin," Oakdale-road, Weybridge. P4123 B

ENGINEER (35) DESIRES RESPONSIBLE POSITION, control of men (pref. London area). Expert power plant and piping systems, energetic, accurate, reliable; factory, D.O. exp., and outside rep. Salary £340 to £350.—Address, P4135, The Engineer Office. P4135 B

ENGINEER MANAGER, Lately Holding Important appointment abroad with leading British firm and possessing sound technical knowledge (mechanical and electrical) and extensive commercial experience, sales organisation and development, home and export, DESIRES RESPONSIBLE APPOINTMENT.—Address, P4134, The Engineer Office. P4134 B

ENGINEER, 1st Class B.O.T., REQUIRES POSITION as Maintenance or Power Plant; 11 yrs. chief engr. of oil tank vessels. London area or near preferred. (Age 42.)—Address, P4156, The Engineer Office. P4156 B

ENGINEER SEEKS CHANGE; Specialist in organisation and production methods, gen. engr., constructional, railway work and contractors. Wide exp. comm. and works management.—Address, P4136, The Engineer Office. P4136 B

MARINE ENGINEER and TWO SONS, Manchester, WANT APPOINTMENT in Alexandria in charge of a depot for a firm exporting steel barges, pumps, valves, &c., to the Nile.—Address, P4130, The Engineer Office. P4130 B

MECHANICAL and GENERAL ENGINEERING DRAUGHTSMAN SEEKS POST (London district); 20 years' varied experience.—Address, P4097 The Engineer Office. P4097 B

S. I. MECH. E., Age 24, REQUIRES POSITION as Technical Assistant; 9 years' practical experience, 6 years' technical training; London preferred.—Address, P4140, The Engineer Office. P4140 B

STEEL METALLURGIST (29) REQUIRES POSITION; technically trained, general steel works experience, home and abroad; heat treatment of forgings and castings, all sizes; electric steel process alloys and castings; would go abroad.—Address, P4141, The Engineer Office. P4141 B

THOROUGH Practical MECHANICAL ENGINEER, age 42, DESIRES responsible POSITION. Well versed in production or maintenance, good correspondent; held managerial positions. Free March 1st.—R., 15, Walford-road, Uxbridge, Middlesex. P4126 B

SITUATIONS WANTED (continued)

FOREMAN PATTERNMAKER (Lanc. Man) DISENGAGED; young and energetic, fully qualified; all types of steam engines, rolling mill plant and millgearing; first-class ref.—Address, P4144, The Engineer Office. P4144 B

MACHINE SHOP FOREMAN DESIRES CHANGE, 24 years' machine shop experience in motor car manufacture and small repetition work; 14 years supervisor; autos. and turrets speciality; keen, energetic and disciplinarian; sound refs.—Address, P4143, The Engineer Office. P4143 B

MOULDER, Exp. Gen. All-round, DESIRES SIT. where keen business acumen, together with strictest integrity and hard work, will bring fair return and perm.—Address, P4124, The Engineer Office. P4124 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 75 years.

FOR DISPOSAL, a LARGE BATCH of SHARES in a well-known Private ENGINEERING COMPANY in Yorkshire of over 60 years' standing. A seat on the board will be available if purchaser has suitable qualifications. Reinvestment under trustee requirements only reason for realisation.—Address, P4142, The Engineer Office. P4142 C

EDUCATIONAL

Correspondence Courses
OF PREPARATION FOR THE
Examinations of the
INST. OF CIVIL ENGINEERS,
INST. OF MECHANICAL ENGRS.,
INST. OF STRUCTURAL ENGRS.,
UNIVERSITY OF LONDON, &c.
are personally conducted by
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Co-operative Profit-Sharing.

THE usual source of our information in past years concerning profit-sharing and co-partnership in co-operative productive societies has been the annual review published by the Industrial Co-partnership Association. The Association has, however, decided to discontinue the publication of these statistics, and we have to turn to those collected by the Co-operative Productive Federation. The Federation's figures deal only with those societies associated with it, but, while covering a smaller number of concerns than did the Association's summary, they give a much fuller survey of the position. The report has just been issued, and gives details of forty-one productive societies, which at the end of 1926 had 14,480 members and a capital of nearly 1½ million sterling. To their 5766 employees the sum of £597,751 was paid in wages. With a trade of 2¼ millions they had a net surplus of £90,596, of which £26,733 was allocated to labour, making an average bonus of nearly £4 13s. 1d. for twelve months, or 1s. 9½d. per week. In the group of metal-working, woodworking and miscellaneous industries, the six societies had a membership of 1228 and a capital of £107,318. At the end of 1926 there were 565 employees and the wages bill for the year amounted to £63,649. With a business of £205,794, there was a net surplus of £2471. Of the six societies, only two had a surplus large enough to permit of a distribution. The Chesham Builders and Decorators, Ltd., with a capital of £3084, did business to the extent of £10,542, and out of a net surplus of £582 distributed among its twenty-four employees the sum of £98, or an average of £4 1s. 8d., giving an addition of 1s. in the pound on wages. The Walsall Lock and Cart Gear, Ltd., had a capital of £45,015. Its sales in 1926 amounted to £80,277, and gave a surplus of £2217, out of which the sum of £1323 was allocated to its 370 workpeople, giving an average of nearly £3 16s. 5d., or a bonus of 9d. in the pound on wages. The figures given above, it will be understood, apply only to those societies associated with the Co-operative Productive Federation. There are, of course, other productive co-operative societies organised on profit-sharing principles. There are also many ordinary commercial firms having similar schemes, a summary of the results of which was given in a Journal Note in our issue of June 24th, 1927.

Abolition of Submarines.

THE question of abolishing submarines, which was raised first by Great Britain at the Washington Conference in 1921–22, has been revived by an announcement from Mr. Kellogg, the American Secretary of State, to the effect that the United States Government would now "be willing to sign a treaty with all the Powers of the world prohibiting the use of submarines entirely." Amplifying his proposal in a letter to the Foreign Affairs Committee of the House of Representatives, Mr. Kellogg explains that an embargo on submarines would be ineffective unless it embraced all countries. Although this announcement is welcomed in British naval circles, it is felt to be somewhat belated. Had the United States adopted the same attitude at the Washington Conference, when Great Britain was urging the prohibition of submarines, there might have been a chance of securing the adhesion of other Powers to such an arrangement. Unfortunately, the United States at that time declined to support the British proposal, which therefore came to nothing. The position to-day is more complicated and the prospects of abolition are slender indeed. In recent years France and Japan have been building submarines in large numbers, no less than 140 vessels being under construction or projected by those two countries alone. Having regard to the important part which the submarine now plays in the defence systems of France, Japan and Italy, it seems most improbable that a fresh invitation to discard the undersea weapon would meet with their approval. Nor can it be overlooked that America herself is proposing to build thirty-two new submarines at a cost of £1,000,000 each. The general impression in this country is that the American Government's announcement has a moral value only, and is not likely to inspire any definite movement towards the abolition of submarines.

Lloyd's Chief Ship Surveyor.

ON Thursday of last week, February 2nd, the General Committee of Lloyd's Register of Shipping conferred the vacant position of Chief Ship Surveyor to the Society upon Mr. James Montgomerie, D.Sc., who has for some time been Assistant to the Chief Ship Surveyor and Principal Surveyor for Scotland. Dr. Montgomerie served his apprenticeship with William Denny and Brothers, Dumbarton, and at the Technical College which he attended at the time he was placed first in the Honours Class in Naval Architecture. In 1897, at the examination of the Board of Education in Naval Architecture, he took first place in First-class Honours in the United Kingdom. He joined the staff of Lloyd's Register as a ship surveyor in 1901, and after a short service in the Glasgow office was transferred to the staff of the Chief Ship Surveyor in London. While in London Mr. Montgomerie obtained the degree of B.Sc. (Honours), and in July, 1918, the degree of Doctor of Science was conferred upon him by London University, his thesis relating to the behaviour of flat plates of shipbuilding quality when exposed to fluid pressure. In 1911 he was selected for service in the New York office of the Society, with authority to pass plans of new vessels to be constructed in the United States. He returned to this country in 1914 and a year or so afterwards was appointed Principal Surveyor for Scotland. During the war he represented Lloyd's Register in the Department of the Controller-General of Merchant Shipbuilding. Shortly after its conclusion he was appointed Assistant to the Chief Ship Surveyor, a position which he has held until the present time. In that capacity he was closely associated with the Chief Ship Surveyor in the revision of the Society's Rules for the Construction and Classification of Steel Ships in 1921, and in the preparation of Rules for Oil Tank Vessels in 1925.

The First Wright Aeroplane.

THE aeroplane on which the brothers Wright on December 17th, 1903, made the first flight on a power-driven flying machine of the heavier-than-air type is now on its way from the United States to this country for housing in the British Museum. It was, we recall, to have been sent across to us a few years ago, but negotiations for its retention on the other side apparently succeeded for a time in delaying its departure from its native land. It would now appear to be definitely on its way at last. The reason why Mr. Orville Wright has chosen the British Museum instead of the Smithsonian Institution at Washington as the resting place, temporary at all events, for the historic machine, is founded on a difference of opinion between him and the Institution over the description attached by the Smithsonian authorities to the machine produced by the late Professor S. P. Langley, and now in their care. Professor Langley, of the Smithsonian Institution, after many experiments with steam-driven models, produced a full-sized machine which on December 8th, 1903, just failed to achieve the first power-driven flight. The Langley machine in 1914 was taken from its resting place in the museum by some admirers of its designer's ability and was fitted with a modern aero-engine and propeller and otherwise modified. In that condition it was successfully flown. On the strength of that performance the machine was hailed by some as rightly meriting pride of place over the Wright machine. On its return to the museum it was officially described as the first heavier-than-air machine capable of carrying a man in free flight. To that description Mr. Orville Wright takes exception. The museum authorities apparently refuse to depart from it, and as a consequence this country is to receive the Wright machine, with which, just on twenty-five years ago, the two brothers achieved their historic twelve seconds' flight.

Rural Electrification.

AT a conference on "Agriculture and the Small Farmer," recently held at the London School of Economics, Mr. R. Borlase Matthews read a paper on "Electricity in Rural Life." Special reference was made to the small farmer, and the paper was illustrated by "Anaglyph" stereoscopic lantern slides, devised by the author. All phases of electro-farming were dealt with, including general farm equipment, bee treatment, ultra-violet light processes, and electric ploughing. The necessity for finding some cure for the depressed condition of the agricultural industry was emphasised, and attention was drawn to the fact that during 1927 the farming industry was one of the four industries heading the bankruptcy list. The case for electrification on a 70-acre farm was considered on a commercial basis. Reference was made to the Lincolnshire scheme being worked out by the author and Dr. A. Ekström, who is the leading authority on rural electrification in Sweden. The plan, Mr. Matthews said, was to develop the whole of that county on modern lines, and to concentrate during the first two or three years on three areas, each of 200 square miles. The scheme, the author said, constituted the first real attempt fully to electrify a large area of land in this country.

The Den of Cowie Viaduct Derailment.

AT 8.14 p.m. on October 3rd, 1927, the 7.50 p.m. up express passenger train, Aberdeen to Euston, suffered partial derailment when travelling at a speed of 50 to 55 miles an hour at or near the Den of Cowie Viaduct between Muchalls and Stonehaven, on the northern division of the London, Midland and Scottish Railway. There were no fatalities and only one case of minor injury among the 350 people on the train at the time, but how near the derailment came to being a great disaster may be judged from the fact that one of the four derailed coaches on the train was dragged across the viaduct till it came within 15in. of the edge. The train was hauled by two engines. Lieut.-Col. Mount, in his report on the mishap, which has just been issued, attributes it primarily to the fracture under vibration of a brake stretcher rod on the tender of the train engine. A piece of this rod about 6ft. long became detached and violently struck the main brake reservoir on the tender. The blow led to the fracturing of one of the straps supporting the reservoir, and as a result the reservoir fell on to the track. The tender and the first two coaches of the train passed over the reservoir, suffering some damage in the process, but the gas tanks on the third coach, a Pullman, struck the reservoir and threw it out from beneath the train. The first four coaches were derailed, but remained upright. The Pullman travelled farthest away from the rails, but was brought back towards alignment by contact with the stone parapet at the beginning of the viaduct. As it was dragged across it began again to move away from the lines, but was again brought back by contact with the parapet at the end of the viaduct. A feature of the accident was the fact that the train travelled 730 to 770 yards after the train pipe had been severed. Colonel Mount does not consider this distance unreasonably lengthy in view of the falling gradient, the speed and weight of the train, and other factors. He comments somewhat severely on the maintenance and inspection services at Ferryhill shed and upon the frequency with which brake stretcher rods had previously fractured on the engine involved in the mishap and on others based on this shed.

Foreign Plant and the Beama.

THE action of the Stockport Corporation in placing a contract with a Swiss firm for a 20,000-kW turbine set at a price of £34,307 against British tenders the lowest of which was £52,220 and the highest £60,815, has evoked a statement from the British Electrical and Allied Manufacturers' Association. In this statement supply undertakings—in particular, those at Edinburgh, Stepney, Newport and Stockport—are accused of using their privileged positions under the national electricity scheme to purchase foreign plant and to force British prices down to a continental level. It is maintained that foreign plant has no economic justification in British power stations. Purely on an efficiency basis British plant, it is claimed, justifies itself at a price 80 per cent. above that of foreign plant. Almost simultaneously with the publication of this statement, the Beama issued a brochure dealing generally with the question of foreign plant in British power stations. In this brochure, taxation comes in for special attention as an explanation of the difference existing in the price of British and continental productions. It is pointed out that while at any one point taxation may represent only 4·5 per cent. of the total cost of production, this element may enter into every item in production from the mining of the raw material upwards, and therefore may exert a very great influence on the final cost of an article. It is also stated that additional burdens are thrown on British industry by the fact that the wages in this country are higher than those on the Continent. In 1927 the average wage in Britain was 1s. 2¼d., in Switzerland 10¼d., and in Germany 9¼d. In addition, British manufacturers have to pay overtime after the forty-seventh hour, Swiss manufacturers after the fifty-second, and German after the fifty-third.

Engineering Appointments on the Clyde and Tyne.

IT is announced by the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, Glasgow, that Mr. Robert Strachan has been appointed a director and manager of the firm's engineering department. Mr. Strachan, who was trained at the Fairfield works, succeeds Mr. Robert Traill, to whom he has acted as assistant during the last seven years. Mr. Traill, it will be recalled, recently resigned from the Fairfield Company in order to take up an important position with Swan, Hunter and Wigham Richardson, Ltd., at Wallsend. Mr. Traill's work at Fairfield has been outstanding, both in connection with the design and development of the Fairfield-Sulzer oil engine and with the construction of modern steam turbine installations for naval and mercantile ships. The quadruple-screw Fairfield-built motor liner "Aorangi," of the Union Steamship Company of New Zealand, Ltd., which was fully described in our early issues of January, 1925, has now completed over three years of service, and is one of the most successful large motor liners afloat. The same type of engines have been installed in the refrigerator vessels "Upway Grange" and "Dunster Grange," of which the second named ship has recently been taken over for the South American service of the Houlder Line, Ltd. Mr. Traill also co-operated with Mr. J. Johnson, of Canadian Pacific Steamships, Ltd., in the re-engining of the "Empress of Australia," which with her new turbine machinery is looked upon as the most economical steamship afloat. That vessel was fully described in THE ENGINEER for June 17th last. Mr. Robert Traill is well known on the North-East Coast, for he was apprenticed to the Wallsend Slipway and Engineering Company, Ltd., in 1884, and rose to be a director of that firm, which he left in 1920 to take up his duties as manager of the Fairfield engine works.

The Application of Model Experiments to the Air Resistance of Trains.

By F. C. JOHANSEN, B.Sc. (Eng.), of the National Physical Laboratory.

I. Air Resistance.

In many branches of engineering, where the provision of all the data necessary for the design of large structures could be attempted only at prohibitive cost and with little prospect of obtaining reliable results, valuable information is obtained from experiments carried out on small-scale models. Such experiments are particularly enlightening in connection with problems involving fluid motion, the solutions for which cannot at present be derived by mathematical analysis. In naval architecture and aeronautics, in fact, a large proportion of the available design data relating to the resistance of ships and aircraft has been furnished by laboratory experiments on models, and the widespread employment by designers of the reports published, for example, by the National Physical Laboratory, no less than the high standards of achievement and economy in marine and aeronautical engineering, are sufficient evidence of the value and reliability of model experiments.

In the province of railway engineering the estimation and reduction of air resistance are matters to which model experiments might be applied with advantage. The cost of experimenting with full-sized trains, the impossibility of controlling the natural wind and the enormous difficulty of segregating the effects of air resistance, are all powerful deterrents against full-scale tests. By comparison with aeronautics, of course, the importance of fluid resistance to trains is somewhat reduced by the circumstance that the air is only one of a large number of contributory agents to the total resistance of a train. Of such agents, however, it has the distinction of experiencing the most rapid augmentation with increase of train speed, being proportional to the square of the relative velocity between the train and the surrounding air. Its magnitude, moreover, at speeds approaching those of modern express traffic, is fully sufficient to command attention. Little reliance, unfortunately, can be placed on such meagre data as are at present available. Out of a large number of train resistance formulæ, the equation—

$$R = 3{\cdot}5 + 0{\cdot}1\,V + 0{\cdot}0015\,V^2 \quad . \quad . \quad (1)$$

where R = total resistance, pounds per ton weight of train; and
V = speed, miles per hour,

has been selected for a basis of discussion as being of about the right order for a passenger train, 500ft. long, of 400 tons weight. The component due to the air is therefore given by—

$$R_A = {\cdot}0015 \times 400\,V^2 \text{ lb.} = 0{\cdot}6\,V^2 \text{ lb.} \quad . \quad (2)$$

for the complete train, which is in fair agreement with the formula—

$$R_A = 0{\cdot}5536\,V^2 \text{ lb.} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

derived from a report by the Electric Railway Test Commissioners at St. Louis, 1904, recently mentioned by Mr. Dendy Marshall.* On the basis of formula (1), the air resistance at 60 miles per hour is 36 per cent. of the total resistance. The horse-power absorbed by air resistance at 60 m.p.h. is thus 346. On the assumptions that the coal consumption of a locomotive at this speed is 6 lb. per tractive horse-power hour, and that the coal costs 30s. per ton, the cost of overcoming air resistance works out at about 28s. per hour's steaming, or, roughly, £4000 per annum for one train. Evidently a strong case can be made out for the reduction of air resistance. On British lines average express speeds are probably nearer 50 than 60 miles an hour; and in other respects the postulated conditions may be somewhat erroneous. There can be little doubt, however, that a reduction of 25 per cent. in the air resistance of main line trains would effect a reduction in running costs of, at a moderate estimate, £50,000 per annum for each of the large British railway groups.

At high speeds the air resistance attains very serious proportions, as will be evident from the following table based on formula (1):—

Train speed, m.p.h.	Air resistance per cent. of total resistance.
60	36·2
80	45·5
100	52·7
120	58·2

The invalidity of applying any existing train resistance formula to speeds beyond those hitherto commonly attained is fully realised. It is, nevertheless, quite probable that the proportions so deduced are of about the correct order. But, however this may be, there can be no doubt that any project involving appreciable increases above present average express speeds would benefit by a preliminary investigation into available methods of predicting air resistance.

For the moment, however, it is the reduction of resistance which should make the stronger appeal, and whilst it is barely credible that railway engineers do not realise the possibilities of economy in this direction, their apparent inattention to aerodynamic problems and the complete absence of appropriate experimental work at the present time certainly lend colour to the suggestion. Nor is any continuous attempt discernible in the design of modern locomotives and rolling stock to remove—as might be done simply and æsthetically—many obvious agents of air resistance.

Some idea of the possible scope for reduction of air resistance can be gained from a consideration of a series of wind tunnel experiments by J. E. Pannell and R. Jones† on the drag of a long smooth cylindrical body of variable length between a rounded head and tail. Their results are presented in the form—

$$R_A = C_1 v^2 + C_2 A v^2 \quad . \quad . \quad . \quad (4)$$

where C_2 is the coefficient for the parallel portion only, C_1 is the coefficient when A = 0, and A is the superficial area of the parallel portion. The application of these coefficients, with a slight increase to allow for the change from a circular cylinder to a rectangular prism, to the case of a body as large as a passenger train results in the formula—

$$R_A = {\cdot}205\,V^2 \quad . \quad . \quad . \quad . \quad . \quad (5)$$

for the air resistance of an aerodynamically ideal form of train. R_A and V are again measured in pounds and miles per hour respectively. The application of model resistance coefficients to a body very much larger than the model and situated in somewhat different aerodynamic conditions involves considerable uncertainty. The coefficient of equation (5) is, however, probably of the right order, and a comparison of equations (3) and (5) indicates that a reduction of about 60 per cent. in the existing air resistance represents the limit of attainment in this direction. The reduction of 25 per cent. which has been cited earlier in connection with fuel consumption economy seems, therefore, to be decidedly within the bounds of practical achievement.

A noteworthy feature which appears in the calculations on the bases both of Pannell and Jones's coefficients—equation (5)—and of those suggested by Dendy Marshall—equation (3)—is that the air resistance attributable to skin friction along the main length of the train is about twice as much as that which is due to pressure components at the head and tail. Attempts to reduce air drag along the main body of the train will, presumably, be more appreciable, therefore, than those concerned with fairing the lines of the locomotive. The possibility—which needs the confirmation of further experiment—is a fortunate one in as much as the external surfaces of the passenger stock lend themselves far more readily and obviously to desirable modification than does the design of the locomotive.

The foregoing considerations form an attempt to show that whilst the air resistance of fast trains is an important source of inefficient operation and uncertainty in design, ample scope exists for its measurement and elimination by means of model experiments. Taken in conjunction with the established success of model experiments as applied to other branches of engineering, they appear to provide a *prima facie* case, for at least a preliminary examination of a few of the factors which call for attention before any such researches may be successfully undertaken.

II. Validity of Results of Model Experiments.

For a full appreciation of the applications and limitations of model experiments in engineering, some notice must be taken at the outset of the principle of dynamical similarity on which their whole validity depends. This principle may be applied to the case of the air resistance of geometrically similar trains by expressing that resistance as a function of all the physical quantities by which it is produced. Thus—

$$R_A = f(\rho\, l\, \mu\, v) \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where R_A = air resistance;
ρ = air density;
l = a typical dimension;
μ = coefficient of viscosity for air;
v = velocity of the train through the air.

By equating coefficients of the several dimensions of the quantities on the two sides of the equation, a general formula—

$$R_A = \rho\, l^2\, v^2\, F\left(\frac{v\,l}{\nu}\right) \quad . \quad . \quad . \quad . \quad (7)$$

may be obtained, where—

$\nu = \frac{\mu}{\rho}$ is the kinematic viscosity of air.

In the present state of knowledge, the function $F\left(\frac{v\,l}{\nu}\right)$ is mathematically indeterminate, and can be evaluated for specified values of the parameter $\frac{v\,l}{\nu}$ only by experiment.

In its simplest form, the resistance of any body may be expressed in the form—

$$R_A = K \cdot \rho\, l^2\, v^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where K is an experimentally determined, non-dimensional coefficient which varies in an unpredictable manner with variations of the parameter $\left(\frac{v\,l}{\nu}\right)$. This variation in the absolute magnitude of the resistance coefficients of similar bodies is known as "scale effect," and it has a peculiar importance in the application of model experimental results to full-scale prediction which will be considered in greater detail below. For the present, it is sufficient to observe that if R_1, ρ_1, l_1, and v_1 refer to a scale model and R_2, ρ_2, l_2 and v_2 to its full-sized equivalent, then—

$$\frac{R_2}{R_1} = \frac{\rho_2\, l_2^2\, v_2^2}{\rho_1\, l_1^2\, v_1^2} \text{ approximately.} \quad (9)$$

If, therefore, by experimental means, R_1 can be measured, it may be equated to the product—

$$K \cdot \rho_1\, l_1^2\, v_1^2,$$

all the terms of which, except K, are known, and K consequently determined. Thereafter the coefficient K may be applied to the full-scale train the air resistance of which will be given by—

$$R_2 = K\, \rho_2\, l_2^2\, v_2^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

with exactness, except in so far as errors are introduced by inability to represent in the model experiments the exact physical conditions which obtain in the case of the full-scale train, and by ignorance of the magnitude of "scale effect."

III. Experimental Methods.

The simple measurement of the air resistance of a model train presents no difficulties that could not be overcome after a little experience. Of such apparatus as is readily available in this country a wind tunnel of the type in use at the National Physical Laboratory suggests itself for the purpose. In this apparatus the model is disposed in an air stream of uniform velocity—which may be varied at will over a range of approximately 20ft. to 100ft. per second—and its resistance measured directly on a balance.

A gradient of velocity and static pressure, which exists along many wind tunnels, is perceptible over a length as great as that occupied by a model train, and would involve a correction to the measured values of the air forces.

The main difficulty in the technique of the model experiments lies in the representation in the wind tunnel of the track over which the train moves in full-scale practice. The proximity of the train and the track is bound to exert a marked influence on the character of the air flow round the train and, consequently, on the resistance to the motion of the latter.

In wind tunnel experiments on road vehicles two methods of representing the ground have been used with a certain measure of success. In one of them a thin, flat plate extending well beyond the model on all sides is arranged horizontally below the model at the appropriate scalar distance from it. Actual contact of the wheels is just avoided to prevent erroneous force measurements. In the other method an exact replica of the model under experiment is inverted and fixed below it so that the reaction between the model and the ground is now represented by the effect on the air flow of the model's image. Neither of these methods is likely to prove very satisfactory when used with a model train. The thin plate introduces a false velocity distribution near the ground, and a slight error in its adjustment will appreciably affect the total resistance of a long, narrow model. The image method is a valid representation of the ground only in so far as the fluid motion is irrotational. In the case of a train, however, many of the eddy-making agents, such as wheels and brake cylinders, occur near to the plane of symmetry of the model and its image, and the value of this form of ground representation may be seriously impaired thereby. With both these methods, moreover, the measured resistances correspond to the condition of still air around the actual train and the effects of natural winds cannot be investigated.

The conditions under which an actual train operates on a calm day involve a velocity of the air relative to the train, but no velocity of the air relative to the ground. These requirements suggest the representation of the track in the form of an endless belt travelling below the model train in the same direction as the wind at speeds which can be maintained constant at any desired value, and varied over a range to include that of the air stream in the wind tunnel. If such an arrangement can be operated, the representation of a train travelling in still air will be attained when the track speed is equal to the air speed, whilst variations above and below that speed will introduce the effects of direct fair and head winds respectively. The track would require to be situated, of course, at the correct scalar distance below the model, and, to avoid an erroneous velocity distribution owing to interference with the free stream at its entrance into the tunnel, could hardly be situated anywhere but close to one of the tunnel walls.

The mechanical difficulties attendant on such a scheme are undoubtedly serious, and so far as is known no opportunity has yet arisen for an attempt at their practical solution. Many of them, however, might be obviated by the employment of a wind tunnel of the "open-jet" type, examples of which are in use in continental and American laboratories. The working portion of this type of tunnel is a jet, freely accessible on all sides, passing across a gap in an otherwise enclosed circuit. Consequently, the

* "The Resistance of Express Trains," by C. F. Dendy Marshall, M.A., published by the *Railway Engineer* (1925).

† Reports and Memoranda, No. 607, Published by H.M. Stationery Office. "Experiments in a Wind Tunnel on Elongated Bodies of Approximately Stream-line Form," by Pannell and Jones.

necessity for effecting the continuity of an endless belt through apertures in the floor of the tunnel no longer arises, and the inevitable leakages at such apertures are avoided. In the absence, however, of a velocity exploration in the neighbourhood of a track situated on the boundary of an air jet, it is idle to speculate on the existence of truly representative conditions.

The influence on resistance of natural winds blowing obliquely to a train is probably so important as to merit special consideration in model experiments. Measurements of resistance will need to be made with the train inclined at angles to the wind direction up to about 45 deg. To avoid interference effects due to the proximity of the side walls of an enclosed tunnel, the ends of the model should not extend beyond the middle four-fifths of the available tunnel width. Even with a large wind tunnel, therefore, the length of a complete model train is restricted to about 12ft. To this scale the cross section of the model is only about 3½in. by 2½in., and considerable skill is demanded in the reproduction of structural details.

The accompanying deviation of the model track becomes, in an enclosed tunnel, a matter of such difficulty as to suggest the alternative plan of determining, without the track, the variations of resistance with angular deviation and of modifying proportionately the accurately determined "direct wind" resistances for the combination of model and track. Thus, if the resistances without track at 0 deg. and 45 deg. are r_0 and r_{45} respectively, then if the resistance at 0 deg. with track is R_0, the resistance with track at 45 deg. will be given approximately by—

$$R_{45} = R_0 \times \frac{r_{45}}{r_0}$$

Such a manœuvre involves a little uncertainty, of necessity, but by no means so much as to nullify the value of the results so obtained. With an "open-jet" tunnel the deviation of the track along with the train model becomes a very simple matter, and all that requires attention is the adjustment of wind and track speeds, so that their motions relative to the train shall truly represent any predetermined set of natural conditions.

IV. Scale Effect.

From an inspection of the general formulæ (7) and (8) for air resistance—

$$R_A = \rho\, l^2\, v^2\, F\left(\frac{v\,l}{\nu}\right)$$

$$= K\, \rho\, l^2\, v^2,$$

it is evident that "scale effect" or alteration in the value of the resistance coefficient K may be introduced by differences, in passing from model to full-scale conditions, in any of the variables v, l or ν. In the present case variations in ν may safely be disregarded from the point of view of "scale effect," since the values of atmospheric density and viscosity are almost identical for both model and train. This does not imply, of course, that barometric changes have a negligible effect on air resistance. Their effect, at constant temperature, amounts, in fact, to about 3 per cent. for a variation of 1in. of mercury in the barometric height. Changes in v and l, however—which may conveniently be regarded as a product—may be considerable, and in the present case are responsible for all the "scale effect" which may occur. With wind tunnels at present in use, a model 12ft. long may be tested at wind speeds ranging from 20ft. to 100ft. per second. The range of $v\,l$ values for the model is therefore 240 to 1200 in foot-second units. For a train 500ft. long, the value of $v\,l$ is 44,000 at a speed of 60 miles per hour, when air resistance is beginning to assume great importance. Some change in the resistance coefficient may be detectable in the wind tunnel between $v\,l = 240$ and $v\,l = 1200$, but obviously it can provide only the barest indication of the direction in which the "scale effect" is tending; and extrapolation beyond $v\,l = 1200$ to $v\,l = 44{,}000$ is a quite inadequate means of estimating the resistance coefficient at the higher value.

Any attempt to predict the "scale effect" between a model and train must therefore be undertaken with extreme caution. Of existing experimental data on the subject, none can be said to be at all strictly comparable. In point of size, shape, and speed, however, there is some similarity between a train and an airship, and the results of resistance determinations for the latter may perhaps throw some light on the order of "scale effect" to be expected in the case of the former. The resistances of R 26 and R 33,‡ predicted by model experiments, were found to be respectively 20 and 14 per cent. higher than those measured by deceleration trials on the actual airships. The full-scale resistances, however, were uncorrected for the accelerating effects of "virtual mass" and were consequently too low by amounts which, in the present state of knowledge, can be only roughly adjudged to lie between 10 and 25 per cent. The resulting net "scale effect" for these airship forms may thus be anywhere within the range ± 10 per cent. of the true resistance. When the smaller scale of the train model is taken into consideration, some reduction of this range of discrepancy may be reasonably anticipated.

Much light would be thrown on "scale effect" phenomena by the accurate determination, in even a single instance, of the air resistance of a full-sized train or railway vehicle. The comparison of its air resistance coefficient with that of its model would furnish a correction factor which might be applied with confidence to other model data. Hitherto, unfortunately, the determination of air resistance alone has not proved feasible in full scale.

Two laboratory methods for extending the $\frac{v\,l}{\nu}$ range in model experiments may perhaps be noticed here. The water tank employs a medium for which ν is one-twelfth that of ν for air. Consequently, a model is tested in water at values of $\frac{v\,l}{\nu}$ twelve times those which obtain at the same speed in a wind tunnel. The maximum speeds attainable through water with existing apparatus, however, are only 20 per cent. of those possible in a wind tunnel. Apart, therefore, from possibilities of increased size of model, the maximum values of $\frac{v\,l}{\nu}$ in a water tank are only two or three times those attainable in a wind tunnel.

In the variable density wind tunnel large values of $\frac{v\,l}{\nu}\left(\text{or } \frac{v\,.\,l\,.\,\rho}{\mu}\right)$ are attained by working with high-pressure air. For the present purpose a pressure of 40 atmospheres would suffice to enable train model experiments to be made at full-scale values of $\frac{v\,l}{\nu}$ Under these somewhat extreme conditions of operation, the cost of construction and maintenance would undoubtedly be great, and for this reason no high-pressure tunnels are as yet in use in this country.

In the absence of more direct sources, it is probable that much valuable information on "scale effect" could be acquired by a comparison of the wind pressures measured at a large number of points on, say, the front of a fast electric train with those at similarly situated points on a model in a wind tunnel. The degree of accuracy obtainable in a large-scale experiment can hardly be estimated, but until such a trial is made the possibility of its being successful need not be disregarded.

It appears, on the whole, that at present "scale effect" must introduce some uncertainty into the quantitative prediction of air resistance from model experiments. It should be borne in mind, nevertheless, that in naval architecture and aeronautics, the data of model experiments can be successfully employed for design purposes, in spite of a similar degree of uncertainty from precisely the same cause.

V. Qualitative Measurements.

In railway engineering, apart from the production of quantitative data, an immense sphere of utility exists for wind tunnel tests in making comparative trials between models of different shapes. The relations between the air resistances of alternative train forms, as determined by model experiments, may be applied in full scale with some confidence. For whilst the variation of resistance coefficient over a wide range of $\frac{v\,l}{\nu}$ values may be appreciable, the actual magnitude of that variation—except for unstable shapes—is known to be only imperceptibly affected by minor modifications of form. Thus, if a change in the shape of a model train is accompanied by a reduction of 20 per cent. in its air resistance, it is very probable that a similar change would produce an equal percentage reduction in the case of a full-scale train. For qualitative measurements, also, the method of reproduction in the wind tunnel of full-scale conditions—*e.g.*, the representation of the ground—is less important than when quantitative measurements are in question and a source of possible inaccuracy loses much of its force. Thus the wind tunnel offers unlimited scope for testing, with a rapidity, simplicity and cheapness elsewhere unattainable, the efficacy of numerous modifications of train form which suggest themselves for the reduction of air resistance.

The manufacture of the scale models for experimental work should present few difficulties to an experienced maker. Lightness and rigidity will be desirable features in them, as much for the improvement of sensitivity in the tunnel balances as from the necessity of maintaining an articulated structure steadily and horizontally during tests.

Further discussion, however, of these and numerous other points of experimental technique would be premature at the moment. What is important now is that air resistance should be recognised as a serious obstacle, alike to increased train speeds and improved efficiency, and that its reduction should be attempted by the same scientific methods as have proved eminently successful with ships and aircraft.

‡ Reports and Memoranda, No. 827. Published by H.M. Stationery Office. "The Prediction of the Resistance of Rigid Airship R 33," by R. A. Frazer and A. G. Gadd.

During the past year there was a substantial improvement in the amount of native labour available for the mines of the Transvaal, the numbers being, on the average, 184,006, as compared with 177,246 for the previous twelve months.

Irrigation in Siam.

The Administrative Report of the Royal Irrigation Department of Siam for the period 2457 B.E.–2468 B.E. (British financial years 1914–15 to 1925–26 inclusive) provides matter for a brief summary of the short history of large-scale controlled irrigation in that country, and for descriptions of some of the more important works and projects. There are also furnished data relating to physical, climatic and commercial conditions, such as enable the reader to form some idea of the general character of this field, in which irrigation is likely to exert far-reaching influence and bring about developments providing employment for engineers. In Siam, irrigation works, such as are being carried out by the Department, have a protective aspect in a minor degree only, their main purpose being to increase production, export and revenue.

Siam is a country in which engineers—civil, mechanical and electrical—as well as contractors and manufacturers of plant in those and other branches are likely to be increasingly interested, possibly to an extent which will surprise those who have not followed recent developments in that well-governed kingdom of some 9½ million persons. Especially should irrigation engineers be concerned to note the activities which are largely due to the labours and advice of the engineers of that branch, whose services the Indian Government lent to the Siamese Irrigation Department, 1913–1915.

Topography, Soil and Rainfall.

That portion of Siam, 30,000 square miles, which is on the Malay Peninsular, is for the most part hilly. In Eastern Siam, 65,000 square miles, the chief feature is a shallow, unproductive depression surrounded by hills. Northern Siam, 60,000 square miles, is mostly forest and mountain land. Except as regards rivers flowing from Eastern and Northern Siam to the Central Plain, none of these areas is of importance in the present discussion.

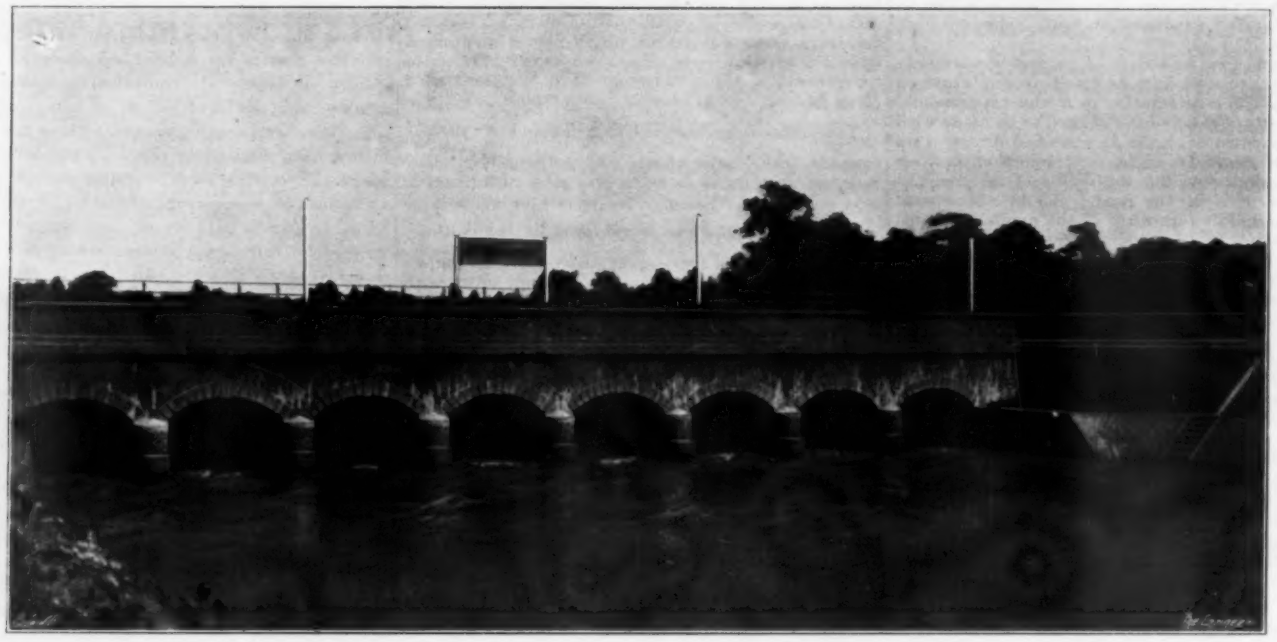
The Central Plain, 55,000 square miles, is almost entirely deltaic, with a few isolated hills. The soil is a stiff alluvium, frequently enriched by floods carrying silt. As in other such areas, the rivers, in the slightly higher-lying portions of the delta, flow on ridges higher than the plain. About a quarter of the plain is cultivated, and the extension of this cultivation depends in part on irrigation and in part on transport. The four chief affluents of the Chenam Chao Phayo, the one great river system of the country, after uniting in pairs, join to form one stream at Paknampoh, 140 miles in a direct line from the sea. From that point the river becomes truly deltaic, dividing into many winding watercourses. Bangkok—population 600,000 and 20 miles from the sea—can be reached by steamers of 1500 tons.

In Central Siam there is a hot season, March–May; a rainy season, June–October; and a cool season, November–February. In a sense the wet season may be considered to begin at the end of April and to last till the middle of November. The rainfall over the catchments of present and future irrigation is from 39in. to 50in., with an average of about 43in., while over the irrigable areas it is about 47in. This proportion vitally affects, of course, the general policy of irrigation, which, however, is dominated by the general condition that the works are those of river diversion, with maintenance of command, but only small storages; in a word, barrage irrigation. Most of the water will be available for increasing production, though in some cases it will in dry years be used in part for the maturing of crops which would otherwise be lost.

In the plain of Central Siam the rainy season is, as indicated in the report, taken as June–November, or part of November, the averages being:—For the season, 41·4in.; June, 6·2in.; July, 7·0in.; August, 7·3in.; September, 10·7in.; October, 8·0; November, 2·2in.

From a table in the report it is found that the average for the principal stations in the plain is 42·3in. for the year. For the kingdom as a whole the figures are:—Rainy season, 48·4in.; the year, 63in. From February to October the temperature in the plains is nearly always between 79 deg. and 98 deg. Fah., while from October to February the range is from 54 deg. to 92 deg. Fah. The average rainfall of 41·4in. for the rainy season in the Central Plain is compared with the following:—Burma, 157·5in.; the plains of Indo-China, about 71in.; Annam, 73in.; Cochin China, 60in.; Cambodia, 61in. The depth of water needed for the rice crop in Siam is 72in., and upwards, so that more than 30in. must be supplied from the rivers in years of average rainfall or less. The most favourable areas have long been developed by means of artificial channels through the river ridges and by inundation during floods. The

PRASAK BARRAGE—HEAD REGULATOR OF SOUTHERN MAIN CANAL



new works will serve similar, productive areas, which are less favourably situated in those respects.

CONTROLLED IRRIGATION.

The first important effort towards the organising of irrigation on a large scale resulted in the establishment, in 1884, of the enterprise known as the Rangsit Concession, whereby a system of inundation canals was completed in 1896, and 350,000 acres of very good land brought under cultivation. The area in which rice matured did not, however, exceed 140,000 acres. This concession reverted to the Government in 1915, and the works were taken over by the Irrigation Department.

The subject of Government-organised and controlled irrigation was first taken up in 1902, and Mr. Homan van der Heide, a Dutch engineer, was appointed to study the area. In his report (1903) he advised that a great controlling barrage should be built across the Chao Phaya at Jainadh at the head of the delta, and the water distributed by three large perennial canals. Such a master barrage was, however, considered too ambitious a project, having regard to what might suffice for many years. An Irrigation Department was formed in 1904, with Mr. Homan van der Heide as Director-General, but although some useful navigation works, as well as other minor works, were carried out, the irrigation schemes which were better suited to the needs of the country were not taken up with energy until the appointment of a Commission in 1912. In 1913, at the request of the Minister of Agriculture, the late Prince Rabi, and by the help of Sir Arthur Peel, the British Ambassador in Siam, the services of a party of engineers were lent to the Siamese Government by the Indian Irrigation Department for eighteen months. Information was collected and supplemented and investigations made, the results being embodied in Sir Thomas (then Mr. T. R. J.) Ward's report. His recommendations were based not only on conditions as regards water and crops, but also on broader grounds of policy and the welfare of the populations to be affected, indirectly as well as directly, by the proposed works. The building of a barrage across the main artery of the country would, he pointed out, present problems affecting much more than irrigation, but he added that a time might come when with a strong demand from a growing population for large, new tracts of irrigated land, the Government, having learned how to solve correctly problems the nature of which he had explained, would find a main river barrage not only desirable, but necessary.

For the immediate future, his specific recommendation was that five schemes, each independent of the others, should be sanctioned, one of them, the Prasak Project, to be taken in hand immediately. In the description of these works information derived from an earlier report of the Royal Irrigation Department and from the Project Estimates has been incorporated with that supplied in the Administrative Report.

ADMINISTRATIVE REPORT, 1914–15 TO 1925–26.

This report contains much information other than that directly relating to the principal works and projects, and presents many facts and data which provide a basis for the understanding of the nature and scope of the work of the Department. Much of the information is, moreover, of considerable interest administratively or technically. We can, however, make a few selections from it.

In order to cope with the low-water conditions of 1919–1920 it was necessary to raise water from the rivers by pumping to the fullest possible extent. There was not time to obtain large pumps from abroad, but useful work was done by using the Department's dredgers as pumps, an area of 21,500 rai (8492 acres) being saved by this means, at a cost of Tcs. 1·91 per rai, or 8s. 9½d. per acre.

The Bangkok Dock Company had a 24in. centrifugal pump driven by a 60 B.H.P. marine compound engine. Since no boiler could be furnished, one which belonged to a steam shovel was retrieved from an abandoned tin mine. This scratch plant did good work: 42 cubic metres per minute against a head of 4 m. Recourse was also had to pumping in 1920–1921 and 1921–1922. In the following year the Department bought two sets of low-lift centrifugal Gwynne pumps, each direct coupled to an Allen heavy fuel oil engine of 140 B.H.P., and rated at 30 cubic feet per second against a head of 25ft. These irrigated 25 rai per hour at a cost of 0·17 ticals per rai, or less than one-tenth of the cost with dredgers, say, 9½d. per acre. These pumps are mounted on a 50-ton steel barge. Another such barge carries a 60 B.H.P. pump and smaller pumps are mounted in barges of 45 to 15 tons, the former being of reinforced concrete.

An abiding trouble with which the conservancy branch has to deal is the obstruction of waterways by Java weed. The cost, some few thousands of pounds a year, is not important, but it must represent work necessary to deal with serious obstruction. This plant, a species of water hyacinth with a beautiful blue flower, is beginning to give trouble in Indian canals also, where timely measures of persecution may, however, suffice to eradicate it. Unless it be dealt with energetically, it forms dense masses which not only prevent navigation, but also stop the flow of water. The first specimens in Siam were brought from Java by the Queen, who placed them in her garden—hence the name, though it is also called "Florida weed," since its original habitat is believed to be in that State, while its appearance and qualities have earned for it the familiar appellation of "blue devil."

THE PRASAK BARRAGE IRRIGATION.

Amongst major works, the Prasak irrigation works, which were formally opened in November, 1924, after having been in operation for some time, are the most notable. The run-off of the catchment of the river Prasak is about 25 per cent. of the rainfall. The ruling feature of the Prasak irrigation is that the water at full supply level upstream of the barrage is only 4·5 m., or less than 15ft., above mean sea level. The river bed is 1·3 m., or 4·3ft., above mean sea level. The barrage commands an area of 197,500 hectares, or nearly 488,000 acres, about three-quarters of which will probably be irrigated eventually. The duty is 700 hectares per mecusec, or nearly 49 acres per cusec. The South Canal is intended to be widened, as may be necessary, to a width sufficient to give it a capacity of 212 mecusecs, or 7488 cusecs, while the Northern Canal will probably have a capacity of 29 mecusecs, or 1024 cusecs. The region includes tidal districts, not irrigable, but capable of being improved by drainage. For its ultimate capacity of 212 mecusecs, the South Canal would require a bed width of 70 m., or 230ft.; at present the bed

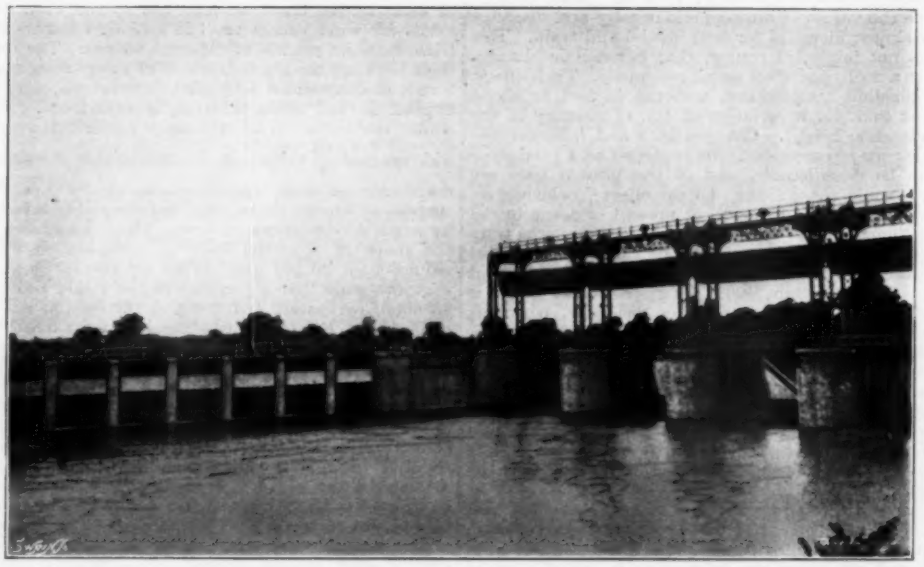


FIG. 1—PRASAK BARRAGE AND REGULATOR FROM UPSTREAM

width is 40 m., or 131ft., the depth 3·0 m., or 9·84ft., and the capacity 100 mecusecs, or 3532 cusecs. In the length of 32 kiloms. to the main fork, its bed width is reduced to a final dimension of 29 m., and its capacity to nearly 77 mecusecs, or 2720 cusecs. The southern branch is nearly 35 kiloms. in length, and the south-western branch a little longer. The main canal and both branches are important traffic routes. The southern branch has a bed width reducing from 15 m. to 10 m., a depth of 3·6 m., or 11·8ft., and a capacity of 39·55 mecusecs, or 1397 cusecs. The south-western or western branch has a bed width reducing from 17 m. to 10 m., at the far end of the Rangsit area, depth 3·75 m., or 12·3ft., capacity 37·36 mecusecs, or 1169 cusecs. The canals have been designed from Kennedy's tables for non-silting velocities, with bed slopes of 1 in 13,000 and 1 in 14,000.

At the site of the barrage near Saraburi, the river Prasak has a surface width of about 100 m., or 328ft., and about half that bed width. The barrage—see Figs. 1 and 2—has six openings of 12·5 m., or 41ft., with Stoney sluice gates of the Ashford type, built at Renfrew by Messrs. Glenfield and Kennedy. These are 7·5 m., or 24ft. 7in., in height above river bed and weigh 41 tons apiece. The whole structure is 23 m., or 75ft., high from river bed. A continuous slab of reinforced concrete, deepened under the piers, forms the foundation, which is protected by three rows of sheet piling extending across the bed of the river. It is surfaced with large blocks of a hard crystalline limestone, which has also been used for the piers. The head regulator—a view of which is given at the head of this article—has eight gates of the same design, as those of the barrage, spans

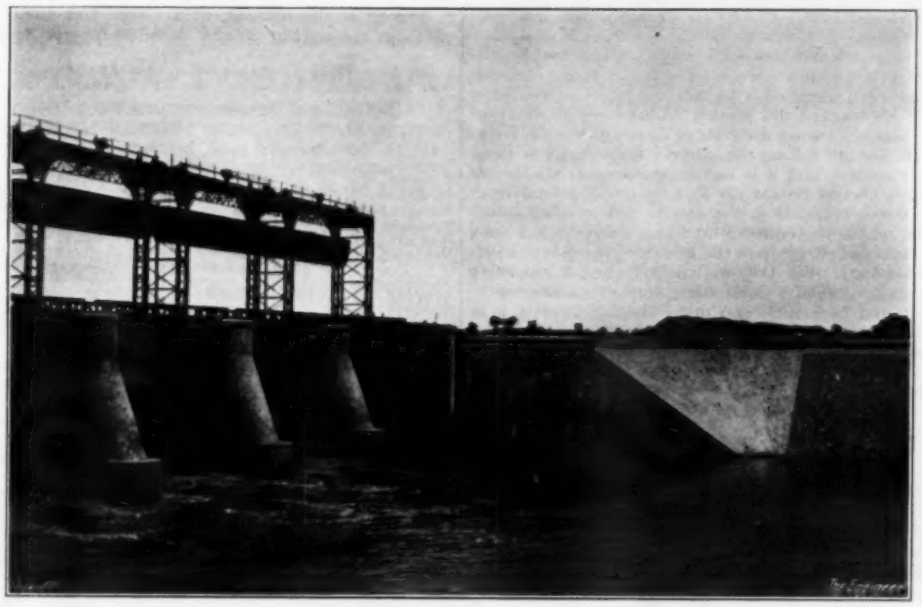


FIG. 2—PRASAK BARRAGE AND REGULATOR FROM DOWNSTREAM

4·2 m., or 13·8ft. A river lock has been provided for the craft plying on this waterway, and it is so designed that a clear passage is left through it during floods. The lift is 7·5 m., or 24·6ft., and the height of the lower pair of gates 9 m., or 29·5ft.

These works absorbed 42,500 cubic metres of rubble stone, 19,000 cubic metres of stone aggregate, 18,000 cubic metres of sand, 7250 tons of cement, 170 tons of steel in the foundations, and 716 tons in the gates and superstructure. The cost of the barrage was Tcs. 2,592,667, or £235,700; of the navigation lock, Tcs. 381,902, or £34,717; of the main and branch canals, distribution, drainage, and protective works, Tcs. 11,958,160, or £1,087,105; establishment and other charges bringing the total to Tcs. 15,780,768, or £1,434,615.

The area irrigated exceeded 300,000 rai in 1923–24, and in 1925–26 was 450,000 rai, or 177·750 acres.

THE SUBHAN PROJECT.

This is one of the schemes recommended by Sir Thomas Ward for the canalisation of the existing channel of the Makamdhao and Subhan river. A considerable amount of work has been done. Full supply level has been fixed at 13 m., or 42·6ft., above m.s.l. At the canal head the bed level will be at 8·60 m. (28·2ft.) above m.s.l., the bed slope will be 1 in 16,666, the bed width 30 m., or 98·4ft., full supply depth 7·2 m. (23·6ft.), the estimated discharge being 270 mecusecs, or 9536 cusecs. Work is proceeding upstream from the third, or lowest, regulator, since the river thus headed up will immediately improve navigation and assist the transport of materials for the works upstream. Work on No. 3 regulator was begun in 1923, and completed in September, 1925. It has two Stoney gates of 12·5 m., or 41ft. span, and 6 m., or 19·7ft., height. The sill is at 0·20 m. above mean sea level, and heading up to 6·0 m. above m.s.l. is provided for. More than £100,000 has been spent out of an estimated total somewhat exceeding £1,000,000.

The cost per square metre of gate was Tcs. 3215, or £292—£27 2s. 7d. per square foot—which compares not unfavourably with that of the gates of the Prasak barrage, Tcs. 2872, or £261—£24 5s. 6d. per square foot—the latter having six openings. The lock is 60 m., or 96·6ft., in length, and its cost per cubic metre of capacity was Tcs. 26, or nearly 36s. 2d. per cubic yard.

THE JIENGRAK AND BANG HIA DRAINAGE PROJECT.

This is a work of drainage for the Rangsit area, largely consisting of the widening and deepening of existing channels, both natural and artificial. A flood embankment is provided to prevent excessive flooding by a hill torrent, the Nakorn Nayak, the regulation of which is the subject of a scheme at present in abeyance. Regulators are so placed that they will assist drainage, or in dry seasons admit a supply of water from the Nakorn Nayak, should it be in flood.

The work involves nearly 240,000 cubic metres of excavation, much of the work being done by dragline excavators. Nearly a third of the total estimate of Tcs. 7,778,760 (£707,160) had been spent by the end of March, 1926.

Full details of the working of dragline excavators in Siam have been furnished by Mr. Percy H. Lee, A.M. Inst. C.E., Director of the Royal Irrigation Department of Siam, in a Government of India Paper, 1921.

Before citing data from the report now under consideration, a few outstanding items in Mr. Lee's report may be noted. The plant included excavators having buckets of 2½ and 3½ cubic yard capacity, and booms of 85ft. and 100ft. The most economical method of working was to employ the excavators in pairs, about 200ft. apart, each excavating half the width. The rate of progress was from 50ft. to 150ft. in twenty-four hours. The fuel used was oil, or, when working far from navigable waterways, wood was employed. The machines, which are self-propelling, could, when the soil was dry, be made to crawl across country at a speed of about 3 miles per week, the rails and sleepers being shifted by coolies. Full costs data are given in Mr. Lee's paper, but the following are taken from the Administrative Report of the Department. On the Prasak works costs per cubic metre for four machines ranged, respectively, in ticals, 0·273 to 0·440, 0·220 to 0·830, 0·321 to 0·580, 0·290 to 0·454, the averages being 0·374, 0·420, 0·490, and 0·423. In pence per cubic yard, these are:—6·2, 7·0, 8·1, 7·0 nearly. On other works the costs in four successive years, 1922–23 to 1925–26, averaged:—Ticals, 0·40, 0·36, 0·23 and 0·24, or in pence per cubic yard, 6·6, 6·0, 3·8, and 4·0. An analysis of costs, 1924–25, furnishes the following, in ticals per month:—Labour, 447·1; lubricating oil, 47·55; fuel oil, 45·42; workshop charges, 44·6; transport charges, 33·0; materials other than oils, 26·07; total, Tcs. 643·64, or £58·51, the cost per cubic metre being nearly 0·08, or nearly 1·33d. per cubic yard.

These working costs may be compared with the total costs already noted. Other examples include one giving the same result and one in which the cost per cubic metre is 0·107, or 1·77d. per cubic yard.

DREDGERS.

The first purchase, of two bucket chain dredgers, was made in 1907. These had an output of 28,000 cubic metres per month when working two shifts, or eighteen hours per day. They dredge to a maximum depth of 4·75 m., or 15·6ft., below water level, and will distribute the spoil through 40 m. of pipe to a height of 5 m. above water level. In all, there were seven bucket dredgers in the charge of the Irrigation Department on revenue account and in service during the period under review, in maintaining the waterways. The rates per cubic metre in different years range from Tcs. 0·12 to Tcs. 0·31, with an exception 0·34. A representative figure, nearly the average, is Tcs. 0·19, or 3·15d. per cubic yard. A suction dredger, purchased by instalments, cost Tcs. 332,388, or nearly £30,000. The items are significant:—Cost of dredger, Tcs. 209,166; freight, insurance and duty, Tcs. 78,523; erection, Tcs. 28,101; spare parts, Tcs. 16,597.

Three Smoke Abatement Reports.

By JOHN B. C. KERSHAW, F.I.C.

THE writer has received recently three reports dealing with the subject of smoke abatement and fuel economy in this country and in Germany, and in the following article he presents the more important of the facts and figures contained in these publications. It is rather unsatisfactory to note that as regards the figures for the total fall of solid matter in London, Glasgow and Birmingham, there has been a slight setback to the continued improvement of the atmosphere which has been in progress since the end of the war. This setback, however, was probably due to the use of imported coal and of coal of very poor quality during the prolonged mining strike of 1926, and it is to be expected that the soot and dust fall returns for the current twelve months ending March 31st, 1928, will again show an improvement.

THE HAMBURG SMOKE ABATEMENT REPORT.

The Hamburg Smoke Abatement Society was founded in the year 1902, and it has recently celebrated its twenty-fifth anniversary. The report for the year 1926 therefore contains an historical sketch relating to the formation of the Society, and also a review of its activities since its foundation. The most interesting portion of this review is that relating to the post-war period 1920–1926, and one of the statements made is that the English coal-mining strike of 1926 convinced Hamburg consumers of the superiority of the Westphalian coals when they could be obtained delivered in the works at the same price as the English Northumberland and Durham coals.

A Steinmuller water-tube boiler, equipped with a horizontal travelling grate stoker, when first examined by the engineers of the Society, showed the low overall efficiency of 65 per cent., this low figure being due partly to inefficient control of the speed of the grate, partly to bad management of the draught, and partly to air leakage through the brickwork. After these defects had been remedied, and the thickness of the fuel bed had been altered to suit the special physical and chemical characteristics of the coal, the efficiency was increased to 75·7. The following table shows the details of the heat utilised and of the heat losses for the two tests, in parallel columns:—

	1.	2.
Heat utilised:		
In boiler	54·7	63·2
In superheater	5·9	6·9
In economiser	4·4	5·6
	65·0	75·7
Heat losses:		
In waste gases	19·1	9·3
Other losses	15·9	15·0
	35·0	24·3

An Automatic Regulator for Steam Boilers.—Another section of the 1926 report is devoted to the subject of the automatic regulation of the fuel feed and boiler draught, so that they can be varied to suit the steam and power requirements of the works or industry. The advantages of any system of control, which will render the engineer-in-charge independent of the human element, are self evident, and are set forth at some length in the report, but until recently no system of automatic regulation has proved entirely successful in Hamburg when tested under working conditions.

The engineers of the Society, however, have had under their supervision, recently, a power installation which has been equipped with a regulator known as the "Askania," and they seem to have been convinced that this apparatus fulfils the demands made upon it, and will provide what has so long been required, namely, a perfectly reliable and rapidly acting automatic regulator, which will increase the rate of firing and the draught on the boiler, according to the demands of the steam-consuming portions of the plant.

The boiler to which the apparatus has been attached is a Durr vertical tube boiler, which possesses a heating surface of 600 square metres, and a grate area of 22 square metres. It is provided with a superheater and an economiser, and the fuel is burned on a mechanical travelling grate stoker. The demands

made upon this boiler vary greatly within the twenty-four-hour day, as shown by the figures in the table given below, and the difficulties that an ordinary fireman would meet with in maintaining a high boiler efficiency under such a variable load are obvious. The "Askania" regulator, however, has enabled the high average of 83·5 per cent. to be attained under these conditions, and Table I. shows that the highest efficiencies were realised during the periods of light load when the automatic system of control would have been expected to show the worst results.

TABLE I.—*Varying Steam Demands on the Boiler Fitted with the "Askania" Regulator.*

Time	8–12.	12–16.	16–20.	20–24.	0–4.	4–8.
Water evaporated in kilos.	69,800	69,940	59,100	56,670	30,545	40,935
Coal consumed in kilos.	7,800	8,000	6,257	5,814	3,200	4,200
Evaporation figure	8·94	8·74	9·44	9·75	9·54	9·75

The details of the test made on this boiler with Westphalian nut coal, and with the "Askania" in operation are as follows:—

Rate of Firing.—1470 kilos per hour (equivalent to 66 kilos. per square metre of grate surface per hour).

Steam Produced.—13,624 kilos. per hour (equivalent to 22·6 kilos. per square metre of heating surface per hour).

Water Evaporated.—9·27 kilos. per kilo. of fuel (equivalent to 9·86 kilos. from 0 deg. Cent. and at 100 deg. Cent.).

CO_2 *in Waste Gases.*—11·1 per cent. (equivalent to an air excess of 69 per cent.).

Heat Balance.

	%	%
Steam produced	71·1	
Superheating	6·89	
Preheating water	5·51	
		83·5
Loss by heat in the waste gases	7·4	
Unconsumed gas	0·7	
Loss by coke in the ashes and cinders	1·9	
Loss by radiation and convection	6·5	
		16·5
		100·0

The conclusion at which the Hamburg engineers have arrived is that, when fuel is burned upon a travelling grate stoker, the "Askania" system of control will prove a keen rival in efficiency and economy to the system of coal-dust firing, since it shows elasticity, and can so easily adapt itself to conditions of varying loads.

The last section of the report is devoted to a description of a new system of preventing the erosion of brickwork along the sides of travelling grate stokers, where the high temperature and the friction of the carbonised fuel have their most destructive action. This protection consists of a series of bars which are set in a recess at the side of the furnace, and have a cooling effect upon the wall at this point. The experience that has been gained with this new device is satisfactory, and it is said to overcome the difficulties described.

ANNUAL REPORT OF THE MEDICAL OFFICER OF HEALTH FOR SALFORD, 1926.

One section of the annual report of the Medical Officer of Health for Salford is devoted to the subject of atmospheric pollution. Although the atmosphere of Salford, as judged by the records obtained from the soot and dust gauges installed at three places within the city, compares favourably with that of the other Lancashire towns in which the observations are made, Dr. Osborne admits that little progress can be recorded in the improvement of the atmosphere in South-West Lancashire during the last few years, and that the deaths from bronchitis, pneumonia and other respiratory diseases in the group of towns surrounding Manchester are still double those in the other large industrial districts of the country. Discussing the figures obtained from the Salford soot and dust gauges, Dr. Osborne estimates that over Salford alone about 3000 tons of dirt are deposited annually from the atmosphere, and that this dirt contains a high proportion of tar and sulphuric acid. The gauge situated in Peel Park has a worse tar record than any other gauge in the country, for in the twelve months ending March 31st, 1926, the comparative figures for Salford were 50, Marple 16, Southport 4, and Headingley (Leeds) 4.

In the latter part of this section of his report Dr. Osborne discusses the remedies for smoke, and states that the solution of the industrial smoke problem is already in sight, and that the domestic smoke problem is the one which now requires attack. He considers that if we are to retain our open fire-grates, a smokeless substitute for raw coal must not only be found, but must be generally used, and he points out that although the supplies of smokeless substitutes for raw coal are at present very limited in amount, they are not being used for domestic heating purposes to the extent they ought to be. Taking the case of gas coke alone, over 8,000,000 tons are produced annually in this country, but comparatively little of this total finds its way into the domestic grate. Two reasons are given for this dislike of gas coke as a domestic fuel, one being that it is so thoroughly quenched with water at the gasworks that it is difficult to ignite, and the other being the unsuitability of the ordinary domestic grate for burning it.

Dr. Osborne points out, however, that both these difficulties can be easily overcome. The coke produced by the vertical retorts which are now used in the majority of large gasworks is much drier and more suited for the domestic grate than the older type of gas coke, and a fire-brick grate can be constructed quite cheaply in which it gives an absolutely smokeless and hot fire. Full details of the construction of the Salford fire-brick grate will be found in the 1925 report of the Salford Medical Officer of Health. The estimated coal consumption of the country for domestic purposes amounts to 40,000,000 tons annually, and since the total output of gas coke is only one-fifth of this total and of anthracite fuel only one-tenth, a very big field of supply is available for the various forms of low-temperature coke, which are now being manufactured and placed on the market in different parts of the country.

AIR POLLUTION IN OTHER ENGLISH AND SCOTCH TOWNS AND CITIES.

The thirteenth annual report of the Advisory Committee on "Air Pollution," covering the twelve months period ending March 31st, 1927, is not yet published; and the figures used in the summary given below are taken from the annual report of the Meteorological Department of the County Borough of Southport for 1927, which contains the record from seventeen towns and thirty-seven gauges. The figures for some of these towns, as, for example, those from Birmingham and Salford, relate to only one or two gauges, and are not comparable with the figures published in the article which appeared in THE ENGINEER on February 26th, 1927. In the majority of cases, however, the figures given in the Southport report relate to the results obtained with all the gauges in use in the period under review, and the comparisons made therefore are just as reliable as if based upon the figures which will appear later in the official report.

As regards the number of gauges in use in different towns and cities, Glasgow still heads the list with nine gauges—London being second with eight—Birmingham and Newcastle having three, and Southport two; while the remaining towns have only one gauge each installed. As noted in the last article in THE ENGINEER, the Health Authorities of many of the manufacturing districts of Lancashire and Yorkshire are not taking the interest they ought in these observations, and it is certainly desirable that more gauges should be set up and results obtained from the towns engaged in the cotton and woollen industries, where the emission of black smoke has a very detrimental effect upon the health of the surrounding populations. Dr. Osborne, in his annual report to the Salford Health Committee, states that the death-rate from bronchitis and other similar diseases is in nearly every case 50 per cent. greater in the Manchester group of manufacturing towns than that of the country as a whole, and that the chief cause of this higher death-rate is the use of bituminous coal in ordinary kitchen open fires, which are generally banked up with slack in order to keep them in while the family are out at work in the mills. In his opinion, very little improvement can be expected in these towns in the purity of the atmosphere until the health authorities show a more active interest in the subject, and take some more active steps to provide a substitute for this method of heating in the homes of the workers.

THE LONDON RESULTS.

Table II. gives the London figures for the total solid matter collected in the gauge of each observation station in the three years 1924–1925, 1925–26, and 1926–27, all the results being expressed as metric tons per 100 square kiloms.

TABLE II.—*London's Soot and Dust Fall.*

Station.	1924–25.	1925–26.	1926–27.
Meteorological Offices	13,097	10,106	11,856
Archbishop's Park	—	14,352	14,976
Finsbury Park	11,687	8,743	10,080
Ravenscourt Park	9,853	6,881	11,664
Southwark Park	11,364	9,221	10,104
Victoria Park	10,323	8,695	8,244
Wandsworth Common	10,950	7,050	7,416
Golden-lane	13,009	17,255	18,588
General average for all stations	11,653	9,944	11,622

It will be seen from the above table that the progress in the cleansing of London's atmosphere, which has been so noticeable in the results of the two previous years, received a check in 1926–27, and that the increase in the average soot and dust fall from 9944 to 11,622 metric tons, was recorded chiefly in the gauges at the Meteorological Office, Finsbury Park and Ravenscourt Park, although the other gauges showed also an increased total of solid matter. The amount of the increase can be more easily grasped, if expressed as tons per square mile—the comparative totals for the three years being 298 tons, 255 tons and 297 tons respectively. The explanation of the increase in London's soot and dust fall in the year ending March 31st, 1927, has been given in the introductory paragraph of this article, and it is very probable that the returns for the current year, which ends on March 31st, 1928, will show a return to the more satisfactory level of the year 1925–26, when the total fall was reduced to 255 tons per square mile.

THE GLASGOW RESULTS.

Table III. gives the Glasgow results for the total solid matter collected in each observation gauge during the same three years as covered in Table II., and it is noticeable here again, that the record for the last year is larger than for 1925–26, although the increase is not so great as in the case of London. When converted into tons per square mile, the comparative figures are 285 tons, 275 tons and 286 tons respectively, and therefore although Glasgow suffered a slight setback in the purity of its atmosphere during the coal mining strike of 1926, the effect upon the amount of sunlight and the health of the population would not be so serious as in London.

TABLE III.—*Glasgow's Soot and Dust Fall.*

Station.	1924–25.	1925–26.	1926–27.
Alexandra Park	9,360	10,294	9,120
Bellahousten Park	9,765	8,609	9,336
Blytheswood-square	12,937	13,257	14,076
Botanic Gardens	14,537	12,428	11,412
Queen's Park	8,209	8,493	9,552
Richmond Park	12,009	11,909	11,100
Ruchill Park	8,941	8,028	9,156
Toll Cross Park	12,061	12,110	13,080
Victoria Park	12,290	11,583	13,932
General average of all stations	11,123	10,746	11,196

OTHER RESULTS.

Table IV. contains the figures for the soot and dust fall of the leading English towns and cities compared with the London and Glasgow averages, for the three years ending March 31st, 1927. It will be observed that some changes have taken place in the relative position of the towns and cities, as compared with those given in the last article. Burnley, however, still heads the list of towns in Group I., with a soot and dust fall equivalent to 866 tons per square mile per annum; and Rothamstead still occupies the place of honour at the bottom, with a soot and dust fall of only one-eighth of this total. Liverpool has changed place with Rochdale as the third dirtiest town in which the observations are made, but, as pointed out in previous articles, Liverpool is provided with only one gauge, which is situated at the north end of the city, in close proximity to the docks and works which produce so much of Liverpool's atmospheric impurity, and three gauges at least would be required to obtain a correct measurement of Liverpool's air pollution.

TABLE IV.—*The Soot and Dust Fall of English and Scotch Towns and Cities for the Three Separate Years* 1924–25, 1925–26, 1926–27.

Town or city.	1924–25.	1925–26.	1926–27.
Group I., with Deposits Over 20,000 Metric Tons.			
Burnley	—	34,754	33,840
St. Helens	15,272	30,360	22,344
Liverpool	23,087	25,383	21,876
Rochdale	25,387	26,034	21,336
Wakefield	24,506	22,534	20,856
Newcastle-on-Tyne	30,141	21,821	20,412
Group II., with Deposits Between 15,000 and 20,000 Metric Tons.			
Blackburn	23,014	18,740	—
Kingston-upon-Hull	16,660	18,649	17,088
Huddersfield	10,932	14,369	16,668
Group III., with Deposits Between 10,000 and 15,000 Metric Tons.			
Salford	15,162	13,350	12,804
Leeds	11,064	10,967	—
London	11,563	9,966	11,612
Glasgow	11,123	10,746	11,196
Birmingham	11,004	9,368	9,528
Group IV., with Deposits Between 5000 and 10,000 Metric Tons.			
Bournville Works	7,762	8,565	7,924
Marple	4,085	3,858	5,352
Group V., with Deposits Under 5000 Metric Tons.			
Kingston-upon-Thames	7,938	8,100	4,884
Bournville Village	—	6,276	4,872
Southport	4,568	4,705	4,368
Rothamstead	6,969	3,690	4,296

In Group II. Huddersfield has joined Blackburn and Kingston-upon-Hull; while Group III. now contains the five cities of Birmingham, Glasgow, Leeds, London and Salford, but Glasgow now takes precedence of London in the cleanliness of its atmosphere. Group IV., which previously contained Birmingham and London, is thus reduced to Bournville Works and Marple; while Group V., which formerly contained only three towns, now includes Kingston-upon-Thames, Bournville Village, Southport and Rothamstead. The latter still retains its position as the cleanest place in which these observations are made, although Southport is now close on its heels. When the results for only one gauge are compared, however, the Woodvale Moss Station at Southport shows a lower total deposit than any other station in this country, since the fall of soot and dust at this place represents only 105 tons per square mile per annum, as compared with 109 tons at Rothamstead. The highest deposit for a single gauge is that of the City-road gauge in Newcastle-on-Tyne, where a total of 902 tons was registered, as compared with 866 tons for Burnley.

Table V. gives the total fall in tons per square

mile for each station during the year ending March 31st, 1927, and is interesting, since it shows the remarkable difference even at the present date, in the cleanliness of the atmosphere in the towns and cities of this country.

ATMOSPHERIC POLLUTION IN 1927.

Comparative figures of the total soot and dust fall expressed as tons per square mile, calculated from the figures in the Southport report.

TABLE V.

Town.	Soot and dust fall.	No. of gauges.
Rothamstead	109	1
Southport	112	2
Kingston-on-Thames	125	1
Marple, Cheshire	137	1
Stoke-on-Trent	206	1
Glasgow	286	9
London	297	8
Birmingham	304	2
Salford	328	1
Huddersfield	427	1
Hull	437	1
Newcastle-on-Tyne	523	3
Wakefield	534	1
Rochdale	546	1
Liverpool	560	1
St. Helens	572	1
Burnley	866	1
Highest and Lowest Results for One Gauge.		
Newcastle-on-Tyne (City-road)	902	
Burnley	866	
Woodvale Moss, Southport	105	
Rothamstead	109	
Kingston-on-Thames	125	
Bournville Village	125	
Marple, Cheshire	137	
Wandsworth Common, London	190	

The Maentwrog Power-house of the North Wales Power Company.

THE issue of THE ENGINEER for August 26th, 1921, contained an illustrated description of the development work which had been carried out by the North Wales Power Company up to that date in the mountainous area lying to the west of the Conway Valley, and in that article details were given also of the generating plant installed in the power station at Dolgarrog on the river Conway, and at Cwm Dyli, almost under the shadow of Snowdon.

Since that time a very large expenditure has been incurred in augmenting the water power storage capacity of the natural lakes lying between the Conway Valley and the Snowdon range of mountains, and the three lakes—Cowlyd, Eigiau and Mellanylydd—have been linked up by a series of tunnels through the mountains and by open leets, so as to form one huge mountain reservoir. A large sum of money has also been expended in repairing the damage that resulted from the bursting of the dam at Llyn Eigiau in November, 1925. The purpose of the present article is to give a preliminary account of the engineering and electrical developments which have taken place in connection with what is known as the Maentwrog power scheme. This development work has occupied 1000 men for nearly 3½ years, and is now approaching its final stages of completion, so that the formal opening of the new power station is expected to take place soon after Easter.

Fig. 1 is a sketch map of the area covered by the new scheme, and it will be seen from it that the district lies south of the Vale of Festiniog, and is rather off the beaten track of tourists in North Wales. The upland valley, the mean height of which is about 700ft. above sea level, lies to the west of the second-class road that runs between Festiniog and Dolgelley, and it is only known to motorists who have travelled by this road through the villages of Trawsfynydd and Tomen-y-Mur or who have stayed at the Tynygroes Inn. The new lake, which will be formed in this area in the course of the next twelve months, is shown by the shaded portion of the diagram, and is the result of the closing of the outlets from the valley on the west and north sides, by the dams marked by thick lines in the map. These are masonry dams of solid construction. The largest and most important are at the Maentwrog end of the new lake, while two smaller structures close the outlets of the valley towards Festiniog. Fig. 2 is a reproduction of a photograph of one of these latter. The farm building lying inside it will probably be submerged within the next few months, for the impounding of the water has already commenced. Near the main dam at the power-house end a considerable depth has already accumulated, and a portion of the direct mountain road from Maentwrog to Trawsfynydd is already submerged. The river which flows through the centre of the district is marked in the map as the Ceunant Llenyrch, and the main dam has been erected about 2 miles above its junction with the river Dwyryd into which it flows. The new lake, when completely formed, will have a length of 3 miles, and will be 1¼ miles wide at one or two points; while its storage capacity is estimated at 1000 million cubic feet, or 6½ thousand million gallons.

The watershed which will drain into this lake covers an area of nearly 30 square miles, and the rainfall of this mountain district averages 99in. per annum, or some three times that of the metropolitan area. The power which will be developed at Maentwrog is not so great as might have been expected from such a large volume of water and high rainfall, for the working head at the power house will be only 600ft., as compared with 1000ft. at Dolgarrog, and 1150ft. at Cwm Dyli. It is not expected to obtain more than 24,000 kW from the Maentwrog power station, when all the machinery is installed and running.

The water will be conveyed from the main dam to the penstock which lies above the power house by a steel pipe line, 10ft. in diameter, and by a length of tunnelling through solid rock, and its final drop to the turbines will be through two steel pipe lines, each 5ft. in diameter, one of which is already in position and is shown in Fig. 3.

The power house—Fig. 4—when fully equipped, will contain three turbines of the Pelton wheel type, direct coupled to 7500-kVA three-phase generators, producing 50 cycle alternating current at 6600 volts. This voltage will be raised by transformers to that required for long-distance transmission, and the power will then be transmitted by direct overhead lines through Corwen to Wrexham and Crewe. The new power house at Maentwrog will also be linked by overhead transmission lines with the existing stations at Dolgarrog and at Cwm Dyli, so that, in case of breakdown at either of those stations, the North Wales coast towns can be supplied with current from the most recently equipped station at Maentwrog.

One of the generating units in the Maentwrog power house is already waiting its test; the second is nearly completed, and the third will be installed probably within the next twelve months.

As regards the cost of these new developments, it was estimated when the scheme was first placed before the Electricity Commissioners that a sum of £1,810,000 would be required to carry out all the work planned up to 1927, and that a further £450,000 would have to be expended during the second five-year period to complete the development. In order to finance the work that has been carried out up to the present date, a public issue of 4½ per cent. debenture bonds was made by the North Wales Power Company in the year 1924, and these bonds were guaranteed under the provisions of the Trades Facilities Act, both as to principal and interest, by the Government.

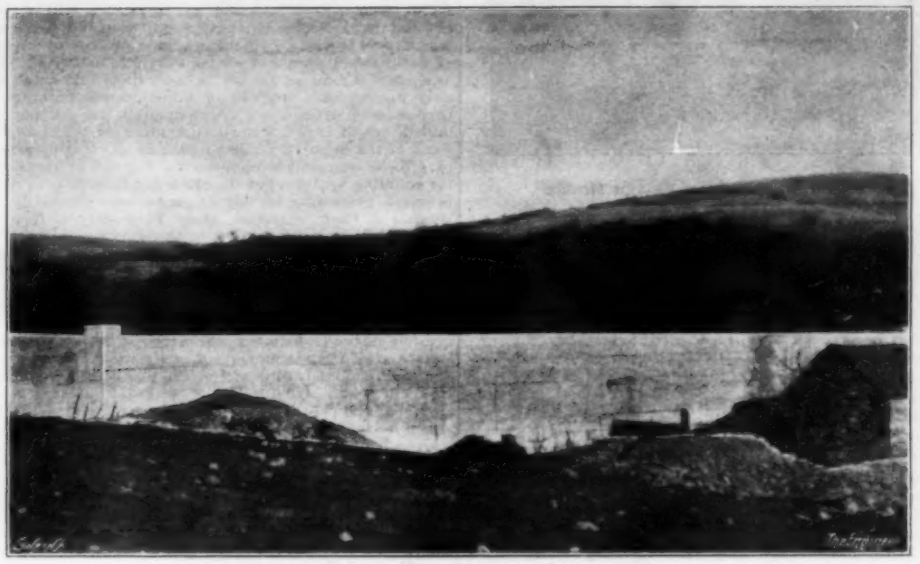


FIG. 2—ONE OF THE SMALLER DAMS

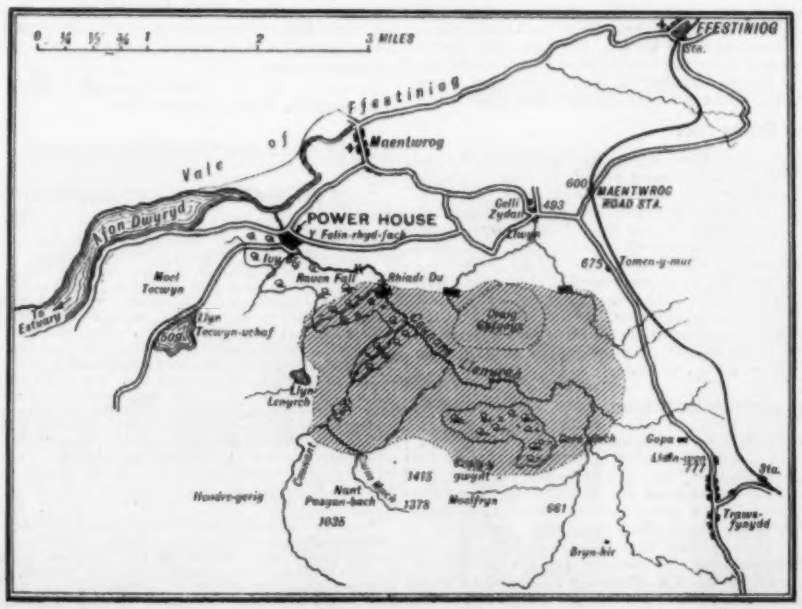


FIG. 1—MAP SHOWING AREA COVERED BY THE MAENTWROG SCHEME

FIG. 3—PRESSURE PIPE LINE

1¼ millions sterling has been raised in this way, and it is possible that a further issue will be required to complete the work before the undertaking is earning sufficient profit to pay interest on the capital involved. The following estimates of expenditure are taken from

FIG. 4—MAENTWROG POWER HOUSE

the official outline of the scheme when it was submitted to the Electricity Commissioners at the public inquiry held in Llandudno in 1921 :—

	£
Hydraulic works at Dolgarrog, Cwm Dyli and Maentwrog	785,000
95 miles of 66,000-volt transmission line, Maentwrog to Wrexham and Dolgarrog to Chester, at £4000 per mile	380,000
68 miles of 33,000-volt transmission line from Wrexham, *vid* Crewe and Northwich to Chester and back to Wrexham, at £2500 per mile	170,000
48 miles of 33,000-volt transmission line from Dolgarrog, *vid* Colwyn Bay, Rhyl and Flint, to Chester, at £2500 per mile	120,000
30 miles of 33,000-volt transmission line from Bethesda, *vid* Bangor to Holyhead, at £2500 per mile	75,000
53 miles of 20,000-volt transmission line to supply the western area, at £1500 per mile	80,000
Sub-station equipment, at £5 per kW	200,000
Toial for the requirements of the first five years	£1,810,000
Further hydro-electric development required at Maentwrog and Cwm Dyli for the second five years	450,000
Total estimated new expenditure in 1921 to provide 137,000,000 units per annum	2,260,000
Add estimated value in 1921 of present hydro-electric installations at Cwm Dyli and Dolgarrog	2,000,000
	£4,260,000

Estimates of Revenue, &c.

	Units.		£
Consumption in 1921	49,000,000	at 1¼d.	250,000
Estimated consumption, 1925	94,000,000	,,	490,000
Estimated consumption, 1930	134,000,000	,,	700,000

The contractors for the work have been: Sir Robert McAlpine and Sons, Ltd., for the general construction and hydraulic engineering work; Siemens Brothers, Ltd., for the electrical work; and Johnson and Phillips, Ltd., for the transmission line. When the Maentwrog scheme has reached its full development, it is estimated that the three stations of the North Wales Power Company will have a generating capacity of between 40,000 and 50,000 kW, and that they will be producing and distributing between 100 and 150 million units of electricity per annum.

South African Engineering Notes.

Cement Supports in Mines.

Mining methods on the Rand have undergone substantial changes during the past five years. The practice of narrower stoping has caused an improvement in the grade of the ore sent to the mill. Rock drills have been made more efficient and have been designed on lines more suited to local conditions than formerly. More effective and economical use is being made of drill steel and explosives than in the past. Machine efficiencies have, in consequence, increased greatly, and the cost of breaking has thereby been reduced, and during the past eighteen months there has been material reduction in stoping with a resultant betterment in yield per ton. Advances have been registered in methods of transporting ore underground, and in almost every direction technique in the mines has been raised to a higher plane of efficiency. The latest phase of a change in technical practice is to be observed in the direction of the improvement of methods of supporting the roof or hanging in the flat reef mines of the Far East Rand.

For some time past there has been a tendency to discard the old methods of support by means of heavy sticks of timber and waste packs or pigstyes of waste rock and poles, and to rely more and more on support by means of concrete. Several of the Far East Rand Mines have for a considerable time been substituting concrete for wood and broken rock, and at the Government Gold Mining Areas may be observed the carrying into effect upon a huge scale of the latest methods of securing the roof or hanging wall by means of concrete supports. Timber and waste rock packs have not entirely disappeared, but in the new order cement is the essential factor, and at this property the use of concrete has reached such dimensions that a large factory for the express purpose of making portable concrete discs or "biscuits" or "pancakes" is now approaching completion. In the Government Areas may be observed the conduct of modern mining methods in narrow stopes where the width is as little as 2ft., and in huge stopes up to 12ft. wide, where values are as impressive as is the width of the conglomerate body. The solidity of the structures which ensure the security of the workings in this the largest gold mine in the world, is wonderful and will enable the extraction of the last ton of ore that is capable of being worked at a profit. Sticks of timber and pigstye have given place to concrete pillars and monoliths—solid columns of concrete with timber cappings—while in some sections solid walls of waste have been built up like the formidable buttresses of some subterranean castle. But, just as the concrete column and monolith have supplanted the waste pack and pigstye, so it is the concrete disc that is to take the place of the pillar. The disc or "pancake" is made of concrete and is 2ft. 6in. in diameter and 4in. thick. Each disc weighs about 200 lb. Government Areas with its eleven million tons of highly payable ore in reserve, with its layout and plant designed for mass production and an assured life of twenty years, can undertake a process of support of workings on a scale of permanency and magnitude such as a less rich mine, or one with a lesser life, could not justifiably undertake. Support of underground workings at Government Areas costs approximately 1s. 2d. per ton milled, which is a not inconsiderable item. The cost of some of the huge 12ft. monoliths is in the neighbourhood of £15—a sum which might seem a great extravagance for a mining venture, but the ore of the Government Areas is worth extracting to the uttermost ton, even if in the process of that extraction many thousands of tons of cement have to be lowered into the workings to take the place of ore pillars, which are worth too much to leave behind. The disc works are situated at the base of the waste rock dump at one of the shafts. They cover four acres of ground, and have cost a very considerable sum of money. The equipment consists in the main of the crusher station, where the waste rock is broken for incorporation with sand and cement in the discs. Next comes the disc manufacturing part of the plant proper, which is of cement and structural steel, and the pickling tanks, in which the "pancakes" are immersed in water. The plant is coming into commission at once, and will have a capacity of about 1500 discs per day. The New State Areas mine will absorb 500 of these, and the balance will be used in Government Areas. In order to ensure an adequate daily supply of properly finished "pancakes," about 40,000 of these discs will be accumulated on storage floors, which are now under construction at surface.

Unusual Cause of Flash-over.

In a contribution submitted to the South African Institute of Electrical Engineers, Major E. F. Rendell describes an unusual type of fault experienced recently on the Victoria Falls Power Company's system. Particular attention has always been paid to the vermin-proofing of all high-tension switch and transformer chambers, but on the occasion in question a flash-over occurred on a set of 40-kV bus-bars, which was due to a cat falling foul of the bottom bus-bar. These bus-bars are mounted one above the other in concrete cells, so as to separate the phases one from another. It would appear that the cat attempted to climb one of the bus-bar supporting insulators, and came into contact with the conductor, with the result that a flash-over which shattered the insulator and destroyed the cat took place. Very careful investigation was required to ascertain how the cat obtained access to the bus-bar chamber, and it was finally disclosed that a space just sufficient for the passage of the animal had been left in one of the secondary cable ducts. Normally the duct is completely closed, but considerable construction work was in progress at the station affected, and in pulling in a new cable the aperture had not been satisfactorily sealed.

Witbank Coking Coal.

It has just been stated in Parliament by the Minister of Mines that a seam of coking coal averaging about 8ft. thick, over an area of about 6600 acres, has been discovered in the Witbank area of the Transvaal. The estimated quantity of coal is over 362 million tons. Of the amount recoverable, 63 million tons are coking coal, which would be sufficient to sustain the production of 150,000 tons of pig iron per year for 125 years. The cost of installing plant will be about £250,000. Examination at various collieries of the main seam worked by the different collieries over the whole Witbank area has proved the existence of coking coal of good quality ranging from a seam thickness of 15in. to 4ft.

Railway Contracts for Belgium.

The tender of a Belgian firm has been recommended for acceptance in respect of fifty fruit wagons for the Union Railways. The price quoted is £26,750. American tenders varied from £33,750 to £40,000, and the German firms quoted a price somewhere between these figures. The only British firm competing quoted at a rate 50 per cent. above the Belgian tender recommended for acceptance. A contract for 200 steel bogie wagons required by the S.A. Railways has been awarded to the Société Anonyme Compagnie Central de Construction, of Haine, St. Pierre, Belgium. The wagons are £303 each, f.o.b. Antwerp. The S.A.R. is shortly to invite tenders for the supply of 100 drop-sided steel bogie wagons each to be 45ft. in length. They are required for coal traffic. A special feature of the contract is that the wagons are to be erected in South Africa, the work of erection being undertaken by the Administration.

Automatic Colour Light Signalling.

In order to cope with the increasing train operations at Cape Town passenger station, and on the suburban line, consequent on the additional train service necessary for transporting the large and rapidly increasing number of passengers, it has become necessary to remodel the existing system of block signalling, and the automatic colour light signalling system was decided upon and is being installed. The system that will be installed between Cape Town and Wynberg provides for the signals to be normally "clear" when the section ahead is unoccupied. When a train is on a block section the automatic signal will show "danger" and will remain so until the train has cleared the controlling section. Certain signals adjoining stations will be regarded as semi-automatic, provision having been made that when the signal cabin at the station is open for trains working the signalman will have control of the signals. The control will be effected through the levers in the signal cabin, and when the latter are in the normal position the signals will show "danger." The track circuit which controls the signal indications displayed to the trainsmen—the signals are worked electrically—provide the indications to the signalman of the actual positions of the trains within the limit of his control, and also of those approaching the station and will prevent an alteration being made to the signals and points that might lead to circumstances affecting the safe working. When the semi-automatic signals are working automatically they will be distinguished by an illuminated letter "A" exhibited on the signal post, but this indication will not be displayed when manual control of the signals is in operation. It will be understood from this that all automatic signals are permanently provided with an illuminated letter "A."

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SEVENOAKS ACCIDENT REPORT.

SIR,—Sir John Pringle's recommendation that permanent way officers should more frequently ride on the footplate of engines will no doubt do much good in keeping better control of the road bed.

I am reminded of a conversation I had with the late Sir John Inglis, the Chief Engineer and, later, General Manager of the Great Western Railway. He was relating many interesting episodes which occurred during his tenure of engineer of the line. The one which applies here was that he was about to get on to an engine of a train from Paddington. The driver, after seeing the engine-pass, was most anxious to know who he (Sir John) was, and after much good-humoured fencing on Sir John's part, was eventually let into the secret. The driver, with words more forcible than polite, wound up by saying that his passenger was "just the man he had wanted to see for a long time."

My own long experience of the footplate quite endorses the suggestion of Sir John Pringle, and I am sure valuable information can be learnt where the shortcomings of the road can be personally observed from that most useful point of vantage, the footplate.

Let us hope Sir John Pringle's very pertinent remarks and suggestion will be taken home and acted upon. They certainly ought to have the most serious attention of both those who have control of the road and also the rolling stock.

The final suggestion of increasing the side play between axle-box and hornstay only repeats what was done on the then Midland Railway some fifty years ago, after a serious derailment at Cornbrook, Manchester.

The two points brought forward by the Inspector are not new, but he does good service by again recalling them to those who at present look after the good running of railway trains.

JOHN PLACE, M.I. Mech. E., &c.

Beckenham, Kent, February 6th.

EDUCATIONAL INTELLIGENCE.

THE SIR JOHN CASS TECHNICAL INSTITUTE.—A course of lectures on "Fuel Technology: Boiler Fuels and Boiler Economy," will be given on Thursday evenings, from 7 to 8 p.m., commencing February 23rd, at 7 p.m., when the chair will be taken by Sir Frederick Black, K.C.B. February 23rd, "Liquid Fuel," Eng. Rear-Admiral A. E. Hyne, C.M.G. (Retd.); March 1st, "Gaseous Fuel," W. A. Tookey, M.I. Mech. E., M.I.A.E.; March 8th, "Solid and Powdered Fuel," B. Samuels, M. I. Mech. E.; March 15th, 22nd, and 29th, "Modern Plant and Working," W. H. Patchell, Past-President Inst. Mech. E., M. Inst. C.E., M.I.E.E. This course, which will consist of lectures of an advanced character, is arranged for advanced and post-graduate students, and also for those who, being associated with industries in which fuel and power are important factors, desire to keep up to date in respect to recent developments. Particulars can be obtained from the secretary of the Institute, Jewry-street, Aldgate, E.C. 3.

FARADAY HOUSE ELECTRICAL ENGINEERING COLLEGE.—The annual examinations for a Faraday Scholarship of fifty guineas per annum, tenable for two years in College and one year in manufacturing works, and for a Maxwell Scholarship of fifty guineas per annum, tenable for one year in College and one year in works, will be held at Faraday House on April 3rd, 4th and 5th, 1928. Exhibitions may also be awarded to candidates who acquit themselves creditably in the above examinations, but who do not obtain the necessary number of marks to qualify for the Faraday or Maxwell Scholarship. The subjects of examination for the Faraday Scholarship are geometry, algebra, trigonometry, dynamics, statics, and hydrostatics, geometrical and freehand drawing, chemistry and physics. For the Maxwell Scholarship the subjects are mathematics, dynamics, statics and hydrostatics. Further particulars may be obtained from The Registrar, the Electrical Standardising Testing and Training Institution, Ltd., 62-70, Southampton-row, London, W.C. 1.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—An exchange of greetings by wireless telephony between the Presidents of the Institution of Electrical Engineers and the American Institute of Electrical Engineers will take place on Thursday, February 16th, 1928, at 3.30 p.m. The message from America will be received in the Council Room of the Institution and in the Lecture Theatre on a loud speaker. Members are invited to hear the message in the Lecture Theatre. Immediately after the exchange of greetings, a cinematograph film, illustrating the new Anglo-American telephone service, will be exhibited.

The Post Office Tube Railway, London.

As long ago as 1909 a committee was appointed to consider the question of providing an underground railway for the purpose of transporting the letter and parcel mails between the principal London post offices and railway stations, but owing to the war and high prices ruling at its conclusion, the railway has only recently been put into operation. It was built to replace the road van service, which, on account of the London traffic conditions, was steadily becoming more and more unsatisfactory. The line—see Fig. 1—runs from Paddington railway station and the

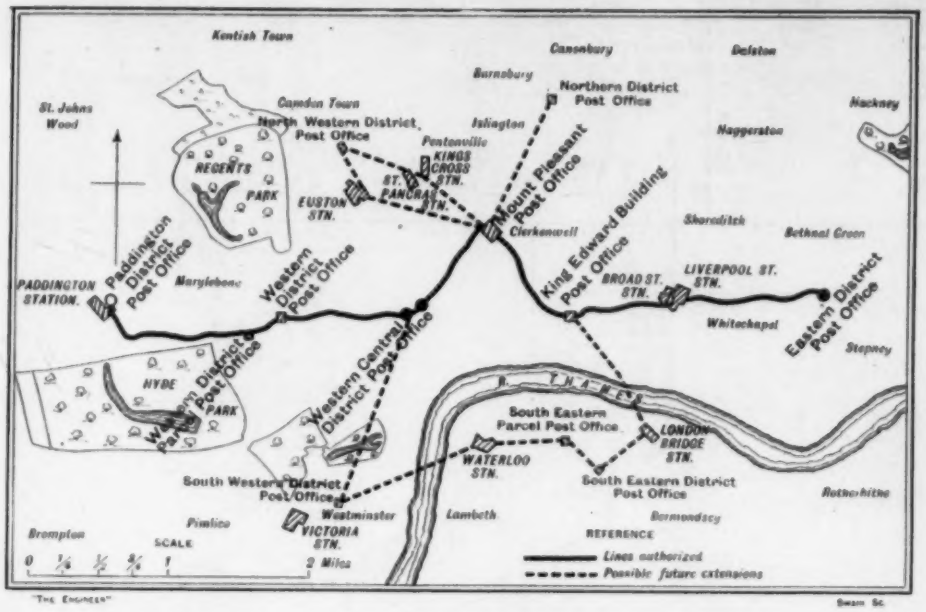


FIG. 1—MAP OF RAILWAY

District Post Office in the west to the Eastern District Post-office in the east, with connections to the Western Parcels Office, Western District and Western Central District Post Offices, the Mount Pleasant Sorting Offices, the General Post Office at King Edward Building in the City, and the railway station at Liverpool-street. The dotted lines on the map show possible extensions, which would provide direct underground connection between the principal railway stations and London post offices. At present the total length of the railway is 6½ miles; the gauge is 2ft., and in order to reduce the cost of constructing the line, both tracks have been placed in one 9ft. tunnel. By reason of the fact, however, that at the stations the platforms are of the "island" type, like those on the ordinary tube railways, there are two 7ft. tunnels for a short distance from the end of each station tunnel to the commencement of the 9ft. tunnel, and the connections between the tunnels of the two different diameters are made by step plate junctions. Illustrations showing the tunnel work are given in Figs. 2 and 3.

In the stations provision had to be made for a through line in addition to the platform line, and at the West Central District Office, Mount Pleasant and King Edward Building, for a running-round loop line as well, thus making three tracks in all. At these three-track stations the internal diameter of the station tunnel is 25ft., whilst at the other stations it is 21ft. 2½in. One of the stations is illustrated in our Supplement. At all the stations there are shafts for giving access to the platforms by means of conveyors, lifts and staircases from the basement level of the various post office buildings, and main line railway stations. Generally speaking, these shafts have an internal diameter of 12ft., although at Mount Pleasant and King Edward Building, which are two of the busiest stations on the railway, some of the shafts are 14ft. in diameter. At Paddington and Liverpool-street there are also conveyor sub-ways, giving direct communication between the main line railway platforms, from which the continental and country mails are received and dispatched, and those of the Post Office railway. At Mount Pleasant there is a similar sub-way. Intercommunication between the "island" platforms is obtained by cross passages, 10ft. in diameter, while other works include the lay-by sidings at each end of the stations at Paddington, King Edward Building, the Eastern District Office, and at the eastern end of the Mount Pleasant station. The trains are controlled from central cabins at the various stations, thus dispensing with drivers.

The running rails are of British standard section No. 35, weighing 35 lb. per yard, and are secured to oak sleepers, which are embedded in the concrete of the tunnel invert. The conductor rails are placed on insulators, 8ft. apart, and so that the upper surface of the rail is 3in. higher than the track rails. At all places where these rails are discontinuous there are ramps which are formed by bending the rail downwards. In the platform sections these conductor rails have a lead of 2ft. 6in. over the track sections, so as to allow a sufficient braking distance and to ensure that the trains shall come to rest in the centre of the platform berth. At places where the rail is interrupted, continuity of the circuit is ensured by jumper cables, which are fixed so that all live metal is kept clear of the track foundation and track rails. The conductor rails are divided into sections, and one is track-circuited throughout to form a control section. In order to increase the capacity of the earth return and to keep the drop of pressure within the limits prescribed by the Board of Trade, bare copper cables are laid throughout.

Current for operating the traction and other equipment is supplied by the City of London Electric Lighting and the Charing Cross and City Electric companies, the mains of which enter a sub-station adjoining the Post Office sub-station at King Edward Building. The railway supplies form part of the general supply taken by the Post Office from these undertakings for power and lighting purposes, and is given in the form of 11,000-volt, 50-cycle, three-phase current. In the sub-station the pressure is reduced to 6600 volts by a bank of transformers with a total capacity of 3000 kVA. The 6600-volt side of these transformers is connected to duplicate bus-bars, and by means of change-over switchgear the supply may be taken from one or other of the two undertakings during different months. The duplicate bus-bars in King Edward Building are connected to the Post Office sub-station at Mount Pleasant by triple three-phase feeders. A supply is also given from the King Edward Building sub-station through two three-core cables to the railway sub-station at Liverpool-street and from Mount Pleasant through two three-core cables to the railway sub-station at the Western Parcels Office, these arrangements being shown in Fig. 4. At Mount Pleasant the converting plant has been placed in a previously existing sub-station, whilst in the other cases the traction equipment is in the invert of the large tube which forms the railway station. One of the rotary converters in these sub-stations is shown in Fig. 5. In each of the traction sub-stations the 6600-volt, three-phase supply is converted into direct current at a pressure of 440 volts. The positive pole of the rotaries is connected through switchgear to the bus-bars of a feeder and distribution switchboard, whilst the negative pole is earthed. At Mount Pleasant, however, where the sub-station is above ground, connection is made to the distribution board in the railway station by cables connected to both poles. At the large railway stations there are two 30-kilowatt motor generator sets, whilst at the smaller stations there are two 20-kilowatt sets. These machines are driven from the 440-volt direct-current supply, and they generate direct current at 150 to 160 volts, which is used when the trains are running into the stations. A supply to the motors for operating the lifts, conveyors and ventilating plant and for lighting is also obtained from the 440-volt bus-bars, either direct in the case of stations where there are sub-stations, or through mains and distribution switchboards. Finally, these two sets of bus-bars are connected by means of cables to the 440 and 150-volt sections of a contactor rack which supplies the different sections of the conductor rail in the particular section of the railway.

The rolling stock, which is shown in the illustrations in our Supplement, consists of steel motor wagons, two or three of which form the trains. Each wagon, which is capable of carrying a load of 1120 lb., is equipped with two 22 horse-power, 440-volt series motors, which are permanently connected in parallel. As the diagram—Fig. 6—shows, the connections are remarkably simple, which arises from the fact that the wagons do not carry control gear. Beyond the two motors, a resistance permanently connected in series with each, and electrically operated brake gear, there is no other equipment. The trains are operated automatically from switch cabins at each station. One of the cabins is illustrated in our Supplement. The motors are energised in the ordinary way from the conductor rail, which is divided into sections, each of which is controlled either by automatic track

FIG. 2—9 FT. TUNNEL WITH TWO TRACKS

FIG. 3—MAIN LOOP LINE AND CAR DEPOT LINE

circuits on the sections between the stations, or by levers working under track circuit control in the station areas. These levers are concentrated in the various switch cabins. In order to start a train, its route is first set and the conductor rail is then energised at 440 volts, when the train runs off down a falling gradient. The same pressure is employed on the conductor rail in the tunnel, where the maximum speed reached is about 35 miles per hour. When a

to stop does not require the continuous attention of the switchman, but its positions in the tunnels and its destination are notified to that official by illuminated diagrams in the control cabin at the station. The switchman is able to receive the train by pulling a lever which sets the points for the appropriate route and energises the various controlling sections of the conductor rail. In general, the method of controlling the station sections is based upon the well-known

kinds of trains, *i.e.*, "All stations" or "M.P." (Mount Pleasant only), and are provided not only with pilot lamps, but also with press buttons. To the right and left of these centre panels there are two other panels from which illuminated train describers on the platforms are operated. One of these describers is to be seen in our Supplement.

Assuming that a train is ready to be loaded at the No. 1 berth of a station platform, by inserting a plug

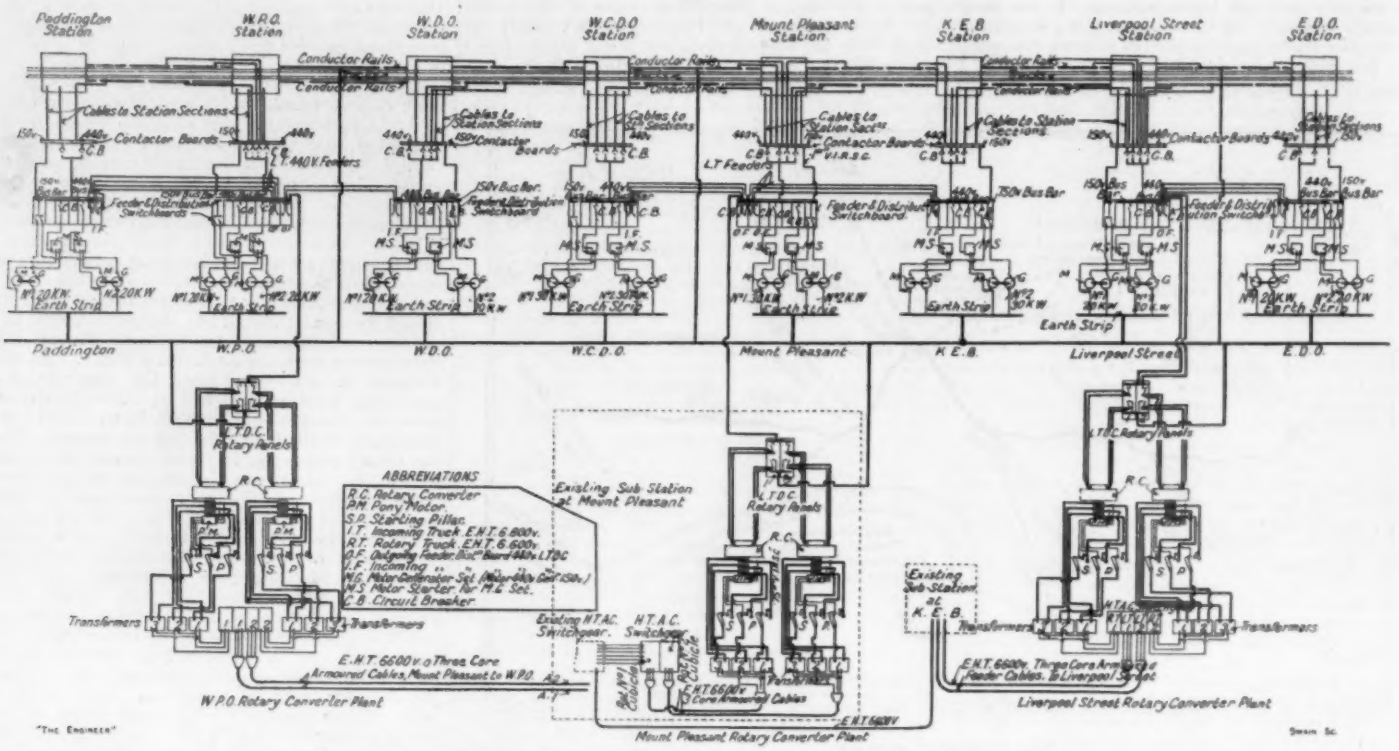


FIG. 4—ROTARY CONVERTER SUB-STATION AND MOTOR GENERATOR CONNECTIONS

station is approached, the train enters a rising section, in which the conductor rail is dead, and it is brought to rest by the automatic operation of the brakes. After a short interval, the conductor rail in this section is energised at 440 volts and remains at that pressure for a predetermined time, which is sufficient to give the train a good start, and at the end of this period the pressure is reduced to 150 volts, and the train runs into the station under that pressure,

"one lever" railway signalling system of Siemens and the General Electric Signalling Company, Ltd., while the conductor rails in the tunnel sections are energised through contactors which are operated by relays working on railway signalling principles. A view of one of the relay cabinets and contactor racks is given in our Supplement.

An illuminated track diagram of the usual pattern fixed in each control cabin shows which of the

in the second jack a panel on the train described, similar to that used on the London tube railways, is illuminated so that the platform staff is informed for what station or stations the train is to be loaded (say, Mount Pleasant). When the train has been loaded the foreman operates a switch on the platform, which lights a green pilot lamp over the appropriate panel in the control cabin and a red light on the platform indicator. The switchman then pulls the appro-

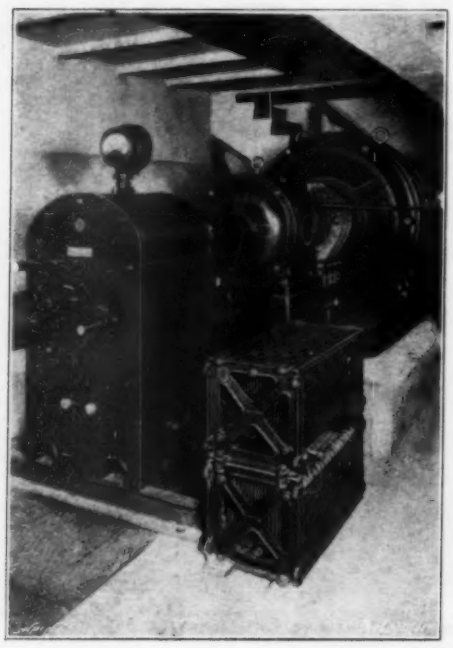


FIG. 5—ROTARY CONVERTER

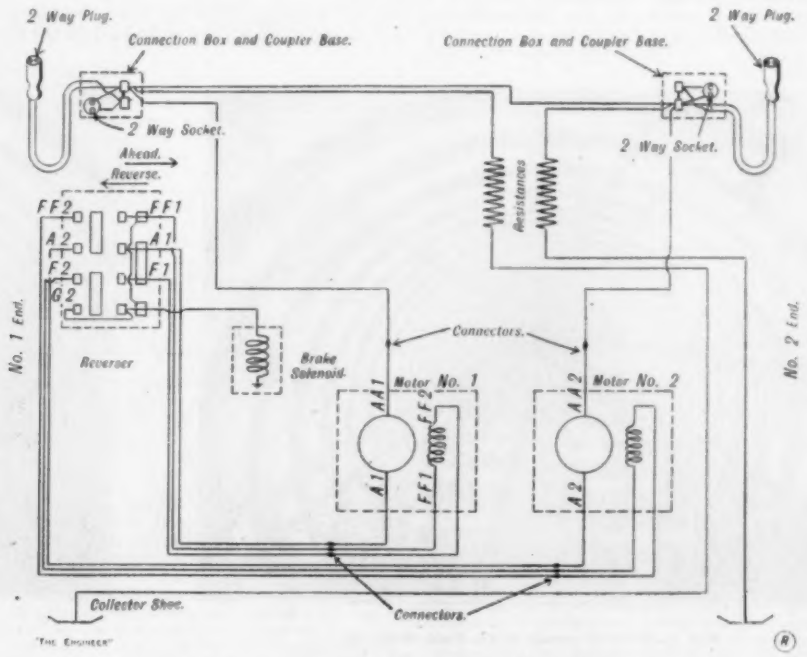


FIG. 6—MOTOR WAGON ELECTRICAL CONNECTIONS

where it either enters a dead platform section and is brought to rest by the brakes alongside the appropriate berth, or if it is not required to stop at the station it passes on to a through section. Operation in and out of the sidings is carried out at pressures of 440, 250 or 150 volts, according to the lay-out of the siding and its approach. All the sections which are normally dead are equipped with conductor rails, which can be energised in the case of emergency. Battery locomotives are available for maintenance work and for hauling broken-down trains. A train passing through a station at which it is not scheduled

sections of the line that are under the control of that particular cabin, are occupied by trains and also by the extinguishing and lighting up of lights, the progress of each train as it enters and leaves the station. Communication between the adjacent control cabins in each direction is effected by means of an indicator board of special design, consisting of four panels, each of which is made up of a number of parallel strips. The two left-hand panels are used for dealing with east-bound trains and the two right-hand panels with west-bound trains. The strips are lettered in accordance with the proposed running of the different

priate lever so as to set up the route and start the train and removes the plug, which extinguishes the platform describer lights. He also presses a button, which cancels the green and red lights and the left-hand button on the strip marked "M.P." on the left-hand panel, which lights two pilot lamps on the second panel of the board at the next station eastward. Having thus received notification of the destination of the approaching train, the signalman at the next station sets the route accordingly, *i.e.*, either for a platform or through line, and presses the left-hand button on the "Receive Eastbound" strip.

This extinguishes the left-hand pilot light of the "Send Eastbound" strip at the originating station westward, as well as the pilot lamp on train describing strip "Mount Pleasant" at that station. There are also buttons on the right side of the train describing strips, and these allow a second train to be dispatched from one station before the arrival of the first train at the next station. Suppose, as before, that a Mount Pleasant train has been dispatched. This is shown by the lighting up of the left-hand pilot lamp on the "Send Next Eastbound" strip. If this train is immediately followed by a "K.E.B." train—a non-stopping train to King Edward Building—when the

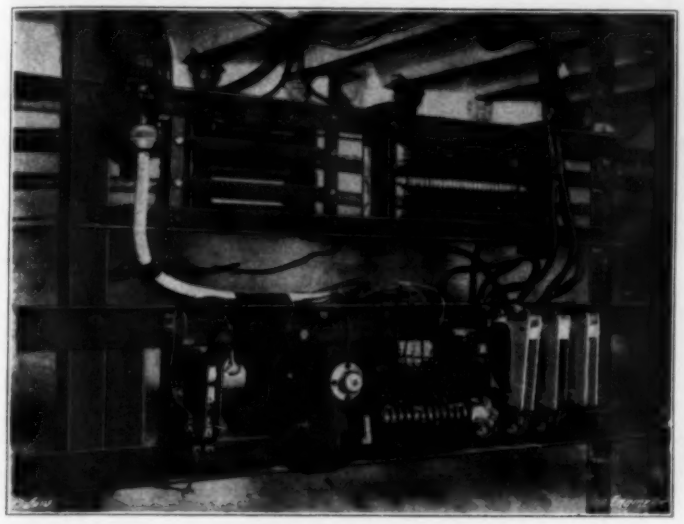


FIG. 7—CAM SHAFT GEAR

FIG. 8—CAR DEPOT AT MOUNT PLEASANT

second train is ready to start the switchman presses the right-hand button on the "K.E.B." strip and this gives a corresponding indication on the appropriate panel at the next station and also lights the right-hand lamp on the "Send Next Eastbound" strip at his own station. The switchman at the next station therefore knows that the first train which is approaching him from the west is going to Mount Pleasant only and that the second train is a fast train to King Edward Building. When, on arrival of the first train, the cancellation is sent in the manner described, the lamps on the right-hand side of the strips are extinguished and the corresponding lamps on the left-hand side are illuminated, thus indicating that the fast train for King Edward Building will be the next train to arrive. Indications for a third train can then be sent forward.

The methods by which the trains are controlled are somewhat complicated, and we do not propose to describe them, but the cam shaft gear shown in Fig. 7 is worthy of consideration. As already stated, as a train approaches a station it runs off the last automatic section on to a braking section which is on a rising gradient, so that the brakes are assisted by gravity in bringing the train to rest. The length of the section is sufficient to ensure that that happens under all conditions, and it has been found that, at any particular station, the time taken for a train to come to rest varies very little. It is therefore possible to select by experiment a time which gives a little margin during which it is quite certain that the train will stop in the braking section. This may be called the braking time. When a train has come to rest in the braking section, the control of the train is taken over by the cam shaft control gear as shown in Fig. 7, which is very similar to the equipment used on the English Electric Company's electric locomotives. The gear consists of a spindle which is driven by a pilot motor through reduction gear, and on this spindle there are three cams which operate three contactors, and the sequence of actuating these contactors is determined by the setting of the cams. The time during which any contactor remains closed depends upon the speed of the cam shaft motor, which can be varied by means of control resistances in series and in parallel with the motor armature. The field of the motor is continuously energised and one side of the armature is earthed, the other being connected to the moving contact of the cam shaft motor relay. The upper contact of this relay is connected to the supply circuit, whilst the lower contact is earthed. Thus, when the relay solenoid is energised current is supplied to the cam shaft motor and the cam shaft is rotated.

When the solenoid is de-energised the armature is short-circuited under full load, thus providing a powerful braking effect which brings the cam shaft to rest without over-running. This solenoid is fed through the contacts of the various track circuit relays of the route concerned, and the fingers and segments on the position regulator. When certain of the fingers on this regulator are energised, as long as these fingers are in contact with their corresponding segments, the cam shaft rotates. The complete rotation of the cam shaft can be divided into four complete zones: (*a*) the braking time, during which the train runs into the section and comes to rest; (*b*) and (*c*) the power zones, during which the conductor rail is energised at 440 volts and 150 volts respectively; and (*d*) the "off" zone, during which it is running on to its starting position. A complete cycle of operations is performed each time the cam shaft rotates through 180 deg. The rotation of the cam shaft from the starting position commences when a train enters the braking section and proceeds either continuously or by stages according to the position of the train. When the train has come to rest on the braking section the cam shaft energises the conductor rail at 440 volts and maintains that voltage for five seconds and thus causes the train to start again. At the end of that period the cam shaft reduces the pressure on the conductor rail to 150 volts and under that pressure the train runs into the station. This is the normal time value which has been obtained experimentally, but it may vary from station to station. The equipment that has been provided for bringing the trains out of the sidings at the various stations is also operated on the cam shaft control principle, and in this case the cam shaft controller is operated by a track circuit in such a way that it

FIG. 9—CAR SHED OVERHEAD EQUIPMENT

rotates up to a certain point and then runs back to zero.

The car depôt at Mount Pleasant—see Fig. 8—has three main tracks together with the necessary cross-overs. Each of these tracks is equipped with a double trolley wire which is supported on H joists secured to the walls of the building. Each of the trolley wires is supplied with current at 150 volts by means of two motor generators. The current from one of these wires passes direct to the motors, whilst the other wire forms a control circuit. As shown in Fig. 9, from the carriage on the H joists two flexible wires are suspended, one of which is led to a plug through which a connection is made to the wagon, while the other terminates in a press type switch which is employed for control purposes. To relieve the pull on the flexible leads the carriage also carries a hemp rope which is attached to the wagon in the manner shown. Contact is made with the trolley wire by cup-shaped contacts which are free to move laterally and are kept in position by springs. Buffers check the movement of the carriage at the end of the run. The socket used for connecting the wagon to the flexible lead and thence to the overhead conductor is that employed for coupling the wagons together to form a train, so that connection is made direct to the overhead conductor without the interposition of the train resistance.

When the wagons are being moved about the car depôt two methods of control can be used. In one case the 150-volt supply from the motor generator passes through a circuit breaker to a contactor, and then to an ordinary controller. This equipment is provided for each of the three car depôt tracks, and it is all mounted together on a raised platform from which a good view of the whole depôt is obtained. The operating coil of each contactor is in series with a small change-over switch, which is normally held in one position by a spring. When in that position, the control circuit is through the contactor coil, change-over switch and one trolley wire to the press switch mentioned above, and then to earth. If, then, the controller is on one of the four running notches, the wagon can be operated from the floor of the car shed by operating the press button, and thus closing the contactor. This enables inching movements to be carried out on the wagons to be moved, thus facilitating movement over the curves. If, however, the change-over switch is moved to its other position, the contactor coil is put direct to earth, when the controller can be operated in the ordinary way and the wagons can be manœuvred from the control platform. In both cases the operating circuit is through the controller and second trolley wire to the wagon motors. All the points are operated by hand levers, which have been specially designed to secure a very positive spring action, and when not in use the levers are sunk in the floor. As the depôt is used mainly for repairs and periodical overhauls, it is equipped with a complete range of tools.

As we have said, there is no control gear on the wagons apart from the series resistance of about 7·6 ohms, which remains permanently connected in circuit with each motor, and the braking equipment and reverser. The two series motors which form the driving unit of each wagon are also permanently connected in parallel and receive their supply when on the railway from the conductor rail, through two separate shoes, one at each end of the wagon. The direction of running is reversed by reversing the direction of current in the field windings by means of a hand switch. The negative brushes of each motor are connected to a common bus-bar, which is connected in turn through the brake solenoid to earth. The equipments of the wagons forming a train are paralleled by means of a bus line and electrical couplers on the negative side of the permanent resistance. When a wagon is standing on a de-energised track, no current passes through the brake solenoid, and the springs therefore hold the brake blocks against the wheels, but as soon as the current is supplied to the conductor rails, the solenoid is energised, the brakes are released and the motor starts, the current being damped by the resistances.

As shown in our Supplement, the loads on the wagons are carried in special containers, which have been designed so that they can be wheeled across the platforms, and there are two distinct types of containers, one for the centre of the wagons and the other for the side compartments. To enable the railway to be worked as efficiently as possible, and to allow full advantage to be taken of the automatic operation of the trains, it is obviously desirable that the

mail bags be passed from the ground level to the railway platforms with as little manual labour as possible, and an extensive system of conveyors, elevators, spiral chutes and lifts has therefore been provided. In general, it may be said that the lifts and elevators combined with the conveyors are used for the upward traffic, and the conveyors and spiral chutes for the downward traffic. Conveyors are employed more particularly for all the up traffic at Paddington and for the parcels at Mount Pleasant, and bag elevators combined with conveyors for the up traffic of letters at King Edward Building and Mount Pleasant. Where lifts are used, the bags are loaded into the containers at the sorting offices and are wheeled to the lifts by hand for the downward journey. At the railway platform level they are wheeled from the lifts by hand to the wagons, where they are placed in position. The elevators, which are of the bucket type, are loaded by conveyors, which are fed through hatches on the Post Office railway platforms. The bags are discharged from the elevators in the post offices, where the contents are deposited either on a short conveyor or on to the floor level. The under platform conveyors at Mount Pleasant and King Edward Building are loaded through hatches in the Post Office railway stations, and deliver their contents on to the elevators. Owing to the lay-out of the Great Western station at Paddington, in relation to the Post Office railway, there is a considerable length of conveyors for the downward delivery of mails. These conveyors, which run in tunnels below the Great Western platforms, are loaded through hatches and deliver their contents on to short conveyors or on to the loading table on the Post Office railway platform. At this station there is an upward conveyor for parcels, which delivers on to the conveyor running to the "lawn," a portion of the station near the southern end of the main departure platforms. There is a similar upwards conveyor for letters and an under platform conveyor connects with the lower parcels conveyor. In all, there are twenty-one band conveyors, five at Mount Pleasant, four at King Edward Building, seven at Paddington, two at Liverpool-street, and one at the Western, West-Central, and Eastern post offices. There are also short conveyors at various delivery points.

The consulting engineer for the civil engineering work and the track construction of the railway was Mr. Harley H. Dalrymple-Hay, a similar function for the equipment being exercised, first by Sir John Snell until his appointment as Electricity Commissioner, and then by Mr. A. M. Sillar. Major H. C. Gunton, Principal Power Engineer of the Post Office, representing Colonel T. F. Purves, Engineer-in-Chief, has been responsible, in conjunction with Mr. Sillar, for the electrical equipment, rolling stock, conveyors and lifts. To these gentlemen, and to Messrs. W. H. Powell and J. R. Kingston, who are assistants to Major Gunton, we wish to express our thanks for their assistance in the preparation of this article. Mr. Evan Evans, whose services were temporarily placed at the disposal of the Postmaster-General by the London Underground Railways, occupies the position of Manager of the railway, and, amongst other improvements, which were incorporated at his suggestion, was the employment of the containers.

The contract for the tunnelling work was awarded to John Mowlem and Co., and Charles Brand and Son were responsible for the platform construction and permanent way. The electrical equipment of the railway was carried out by the English-Electric Company. The E.H.T. and L.T. cables, other than those incorporated in the control system, were supplied by British Insulated Cables, Ltd., and Robert W. Blackwell supplied the track equipment.

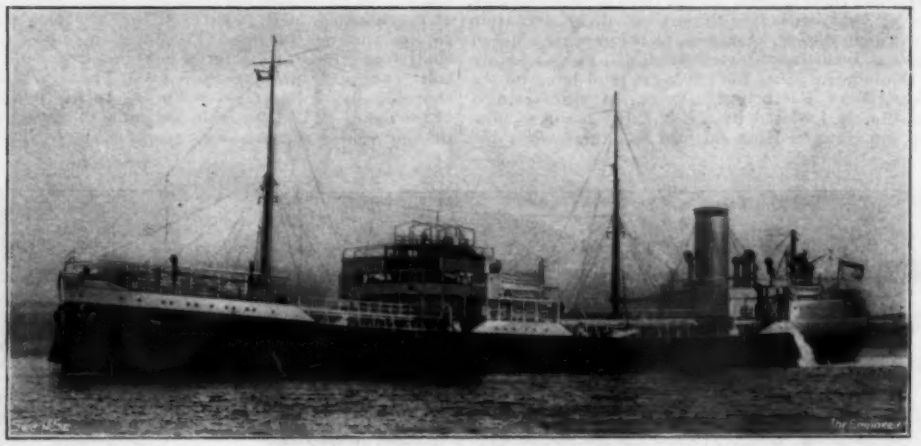
The Motor Tanker "Elax."

INTEREST in the large order for twelve 10,000-ton motor tankers for the service of the Anglo-Saxon Petroleum Company, Ltd., of London, which was completed in Great Britain and Holland last year, was revived last week by the visit of the tanker "Elax" to the Thames. It was the intention of her owners to invite a representative company of engineers to view the ship, and have luncheon at Thameshaven, but owing to the fact that on Friday last, February 3rd, the tanker was still discharging petrol, and was not gas free, permission to take a large party to the ship was at the last moment refused by the Port Authorities. A very small party was, however, enabled to inspect the vessel under the personal guidance of Mr. C. Zulver, the owner's chief superintendent engineer, and Mr. G. J. Lugt, of the Werkspoor Engine Works, Amsterdam, and in what follows we give impressions we were able to gather as to the working of the machinery and its behaviour in service. The "Elax" is the last ship to be completed of the six built and engined in Holland, and she was constructed at the Amsterdam yard of the Netherland Shipbuilding Company, and engined by Werkspoor.

A view of the "Elax" is reproduced in the accompanying engraving. She has a length of 440ft., with a beam of 59ft., and a depth to the upper deck of 32ft. 9in. Her deadweight carrying capacity is 10,000 tons, and her designed speed is about 12 knots. The propelling machinery is placed aft and comprises a single-screw Werkspoor double-acting four-cycle engine, with a designed output of 3500 B.H.P. at 95 r.p.m. The six cylinders each have a bore of 820 mm., with a stroke of 1500 mm. The installation is particularly interesting because the "Elax" and

THE MOTOR TANKER "ELAX"

THE NETHERLAND SHIPBUILDING COMPANY, AMSTERDAM, BUILDERS



her sister tankers are all equipped with the Lugt-Zulver patented valve gear. The general principles of this gear were described in THE ENGINEER of February 12th, 1926. It consists essentially of a single circular valve casing, in which six small poppet valves are accommodated, which, by means of an oscillating sleeve, are made to serve in turn as air inlet and exhaust valves.

Although a considerable departure was made from standard practice when this gear was adopted, the working results have, we understand, fully borne out the confidence placed in the design. During the two months the "Elax" has been at sea, over 2000 miles have been covered, and there has been no stoppage of machinery at sea. The new valve gear has, we learn, proved reliable in service, and it has been found to be more readily accessible than the ordinary valve gear, and is very quickly replaced.

On the bottom cylinders ordinary inlet and exhaust valves are fitted, and these have not been withdrawn since the engines were put into commission, while in the sister ship, the "Phobos," these valves were not examined until after the six months' guarantee period had expired, when they were found to be in good condition.

The general manœuvring characteristics of the engine seem to be remarkably good, and we gathered that there has been no trouble with the engines in any of the sister ships.

The fuel oil used is the ordinary run of Diesel fuel oil, which is untreated, and a very moderate consumption has been recorded. The same lubricating oil serves for the main cylinders, the bearings and the air compressors, and for this purpose the owner's Shell C 3 oil is always used.

Another interesting feature of the installation is the use of main pistons cooled by fresh water, and inspection of the fresh water tanks showed no contamination with oil of any kind.

There are three auxiliary generator sets in the ship, each comprising a 50 B.H.P. Werkspoor engine coupled to a 24-kW generator. As most of the auxiliary pumps are driven directly from the main engine, the size of the auxiliaries is kept small, and one set suffices to meet all power and lighting requirements when at sea. Two marine type boilers are installed on the ship, and steam is kept up in them by passing the exhaust gases from the main engines through the boilers. By such means work on unloading the ship can be begun immediately she is docked, and this facility, and the ease with which the engine valve gear is overhauled, gives, we learn, a very quick turn round to the ship. It will be recalled from our issue of January 6th that two sister ships to the "Elax," the "Buylesses" and "Bullmouth," were built and engined by Hawthorn, Leslie and Co., Ltd., while the North-Eastern Marine Engineering Company, Ltd., engined a further four ships, two of which, the "Pecten" and "Patella," were built by Palmers Shipbuilding and Iron Company, Ltd.

SPEED AND SAFETY ON THE RAILWAYS.

A PAPER entitled "Speed and Safety on the Railways," by Mr. Raymond Carpmael, Assistant Engineer, Great Western Railway, was considered by the Institute of Transport on the evening of Monday last, February 6th, in the Hall of the Institution of Electrical Engineers. The paper was too long to be taken in full, and parts of it only were read by the author, who, in a short introduction, defined the senses in which the words "speed" and "safety" should be regarded in connection with railways. "Safety on railways in its relationship to speed conveys," he said, "little meaning without a proper conception of the railway systems of the world; the general methods of working of traffic; and, in the case of British Railways, of the relationship between the railway industry and his Majesty's Government, as represented by the Ministry of Transport, a relationship closer than that with any other industry."

Mr. Carpmael then proceeded to discuss the matter under various headings. First, there was a long section dealing with the history of the subject, and in it the inception and growth of railways—especially those of this country—were outlined. Then came a section devoted to "Governmental Control and Legislation," which set out how severe was the control exercised by the Government on the construction and operation of our railways.

"Traffic Working and Precautions taken to Ensure Safety" were the next subjects dealt with in what was among the most interesting portions of the paper. The author then reviewed, successively, "Rules and Regulations," "The Conditions Governing Traffic Movements"—another most interesting section—"Particulars of Speed of Trains and of Locomotive Performance," "The System of Inspection of Way and Works and Rolling Stock," and, finally, "Safety in Railway Travel."

In appendices information was given regarding:—(*a*) The Great Western Railway system of automatic train control; (*b*) Periodical examination of engine parts; (*c*) Inspection and testing of materials; (*d*) Testing of permanent way materials; (*e*) Inspection and testing of materials for bridges and steel structures; (*f*) Analysis of accidents to staff of railways, 1905–1924; (*g*) Accidents reported, 1876 to 1925 inclusive; (*h*) Passengers killed in train accidents, 1875 to 1924 inclusive; and (*i*) Servants killed in train accidents, 1875–1924 inclusive.

The paper, which evoked an interesting discussion, is full of railway information of various kinds, and should prove of considerable value for reference purposes.

THE INSTITUTE OF METALS.

THE twentieth annual general meeting will be held at the Institution of Mechanical Engineers, at Storey's-gate, Westminster, S.W. 1, on Wednesday and Thursday, March 7th and 8th, 1928. On March 7th the annual dinner of the Institute will be held at the Trocadero Restaurant and will be followed by a dance, ending at midnight. In the afternoon of March 8th members and their ladies are invited to take tea with the President and Council at the new offices of the Institute, 36, Victoria-street, S.W. 1, on the occasion of a "house-warming."

The following programme has been arranged:—On Wednesday, March 7th, at 10 a.m., there will be a general meeting in the Hall of the Institution of Mechanical Engineers, when the retiring President will induct the incoming President into the chair, and the new President (Dr. W. Rosenhain) will read his presidential address. Subsequently various papers will be presented and discussed. The meeting will be continued during the morning of March 8th, when further papers will be considered.

The papers expected to be submitted are:—A. L. Norbury, D.Sc., "The Effect of Quenching and Tempering on the Mechanical Properties of Standard Silver;" R. Chadwick, "The Constitution of the Alloys of Magnesium and Zinc;" Hugh O'Neill, "Historical Note on Density Changes Caused by Cold Working of Metals;" William A. Cowan, "Minute Shrinkage Cavities in Some Cast Alloys of Heterogeneous Structure;" William A. Cowan, "Note on the Composition of Old Roman Lead;" J. Newton Friend, D.Sc., and W. E. Thorneycroft, "An Example of Roman Copper 'Soldering' and Welding from Uriconium;" Major F. S. Grimston, C.I.E., "Season Cracking of Small Arms Cartridge Cases During Manufacture;" G. L. Bailey, "The Influence of Dissolved Gases on the Soundness of 70:30 Brass Ingots;" J. Newton Friend, D.Sc., "The Relative Corrodibilities of Ferrous and Non-ferrous Metals and Alloys: Part I., The Results of Four Years' Exposure in the Bristol Channel;" Ezer Griffiths, F.R.S., D.Sc., and F. H. Schofield, "The Thermal and Electrical Conductivity of Some Aluminium Alloys and Bronzes;" T. E. Allibone and C. Sykes, "The Alloys of Zirconium.—I.;" S. Beckinsale and H. Waterhouse, "The Deterioration of Lead Cable Sheathing by Cracking, and its Prevention;" Dr.-Ing. Max Haas, "The Dilatometric Study of Light Metals;" F. Hargreaves, "The Ball Hardness and the Cold Working of Soft Metals and Eutectics;" W. L. Kent, "The Behaviour of Metals and Alloys During Hot Forging;" and Tsotomu Matsuda, Sc.D., "On the Quenching and Tempering of Brass, Bronze and Aluminium-bronze."

ACCORDING to the *Great Western Railway Magazine*, the stationery supplied to the company's stations and offices last year included:—1¼ million pens, ¼ million pencils, 5½ million invoice forms, 20½ million telegraph forms, 2 million correspondence covers, ¾ million sheets of brown paper, 8½ million envelopes, 7¾ million sheets of duplicator paper, 11 million pins, 40 thousand pints of ink. Passengers' tickets numbered 64 million, equivalent to 2022 miles of tickets, if placed end on end. For timetables, posters, handbills, excursion programmes, &c., 575 tons of paper were required.

Railway Matters.

THE Southern Railway is fitting to some of its locomotives a plate on each side of the smoke-box whereby the current of air over the front of the engine will be forced upwards and so lift the smoke and steam from the funnel clear of the driver's vision.

THE turret-clock, four double-dial platform clocks, and sixteen other clocks at Newton Abbot, Great Western Railway, are all electrically controlled by one and the same circuit. A beginning has been made with a similar control for the clocks at Paddington.

DURING the present year the Southern Railway proposes to build thirty-eight new locomotives, ten of which will be of the "Nelson" class. It is also proposed to build 1650 open goods wagons of 12 tons capacity, which, it is said, will cost over £250,000.

ENGINES "No. 4021" and "No. 4030" inclusive on the Great Western Railway are of the "Star" class, and bore the names of kings. In order that they should not be confused with the new "King" class, they have been renamed after monarchs, *e.g.*, the "British Monarch," "Belgian Monarch," &c.

CABLE advices from South Africa intimate that the order for the much-discussed thirty-nine locomotives is being divided between the North British Locomotive Company and the firm Ernesto Breda of Milan. The former is to build twenty-nine and the latter the remaining ten. Henschel und Sohn sent in the lowest tender.

IN this column of our issue of February 11th, 1927, we mentioned that the Great Western Company was trying some anti-friction clips to the switches of certain points in Reading yard. It has now been found that considerable economy has been effected in the maintenance of points, and their actuation has been facilitated. As a result of the experience gained the fittings are being provided at a number of other places on the system where the working of points is unduly difficult.

THE unusual use of Waterloo as a departure point for the removal of the body of Field-Marshal Earl Haig to Scotland on Friday last caused some comment. The remains were conveyed by a special train from Waterloo, over the West London line to Willesden Junction. For that journey the Southern Railway provided three coaches and the engine power. Thence the three carriages were worked special throughout to Edinburgh, Princes-street, by the London, Midland and Scottish Company.

ACCORDING to the Melbourne correspondent of *The Times*, the Railway Commissioners of Victoria have felt it necessary to issue a public notice dissociating themselves from the policy of the Minister of Railways in his preference for Australian manufactures. Cases have occurred in which the Railway Commissioners have recommended the acceptance of British tenders, only to have fresh tenders called for when Australian manufacturers have their attention drawn to the new advertisement, and even told by what amount their previous too high tenders must be reduced in order to be lower than the British.

THE Board of Trade export tables for December show the value of the railway material exported during the whole of the year 1927. The figures are as follows, the corresponding sums for 1926 and 1925 being added in brackets: — Locomotives, £2,286,543 (£3,043,131), (£2,558,887); rails, £3,587,623 (£1,347,623, £1,896,960); carriages, £3,113,502 (£2,742,908, £1,619,601); wagons, £3,172,437 (£2,731,984, £3,671,191); wheels and axles, £860,764 (£422,765, £599,540); tires and axles, £728,076 (£289,041, £437,775); chairs and metal sleepers, £1,392,860 (£638,639, £1,023,332); miscellaneous permanent way, £1,488,733 (£1,096,364, £1,439,858); total permanent way, £8,318,164 (£3,969,136, £5,604,327). The weight of the rails exported was 429,391 tons (164,317 tons, 207,615 tons), and of the chairs and metal sleepers, 140,453 tons (65,618 tons, 94,126 tons). During the month of December, 1927, alone, locomotives to the value of £232,673 were shipped overseas, which included:—India, £126,705; Ceylon, £17,145; the Argentine, £15,178; other countries in South America except the Argentine, £13,554; Straits Settlements, £3379. The exports of rails in the same month totalled £444,260, and included:—India, £162,748; Australia, £58,754; the Argentine, £52,900; South Africa, £12,426; British West Africa, £2104; Straits Settlements, £2006.

IN our leading article last week on the Sevenoaks derailment, we mentioned the report by Lieut.-Colonel Mount on a derailment at Bearsted, also on the Southern Railway. It occurred on Saturday, August 20th, four days earlier than the Sevenoaks accident. The engine in that case was No. 890, also of the "River" class, but with three cylinders. The Bissel truck, however, remained on the road, and it was the right-hand leading coupled wheel that left the rails, being followed by the other coupled wheels and trailing bogie of the engine and all the eleven vehicles except the rear bogie of the tenth coach and the rear van. The line at the scene of the derailment was practically straight. As Colonel Mount's report is dated nearly two months earlier than that by Sir John Pringle on the Sevenoaks accident, the greater part of the former need not be noticed here, seeing that considerable space was devoted to the "River" class of engine—all of which was subsequently covered by Sir John Pringle, whose report was very fully summarised in our last issue. The state of the track is also considered at length, but perhaps it will suffice for our present purpose to say that the divisional engineer stated in his evidence that had he known of the prevailing conditions at Bearsted he would have imposed a speed restriction of 15 miles per hour on all traffic. Colonel Mount concludes his report thus:—"Modern conditions involve endeavour to improve facilities by increasing the weight of trains, and therefore necessitate the production of heavier engines. It is equally necessary for the process of track betterment, particularly in relation to the provision of a sufficiently and properly drained ballast bed, to keep pace with this expansion. Experience shows that such provision in the long run makes for saving in maintenance charges, prolongs the life of track material, and, considered broadly, is as essential as other important services."

Notes and Memoranda.

THE production of smelter copper in the United States during last year amounted to some 1,696,000,000 lb., as compared with 1,740,000,000 lb. in 1926.

DURING a discussion on the safe use of explosives in mines, held by the Lancashire branch of the National Association of Colliery Managers, Mr. C. Newton said that quite one-third of the misfires were due to bad detonators, roughly one-third to weak detonators, and the remainder to defective powder.

IT is estimated that the Dambo lode of the N'Changa copper deposits on the Rhodesia-Congo borderland contains from 12 million to 15 million tons of ore averaging just over 3 per cent. of copper. Of this amount over 8 million tons of 3·75 per cent. ore are claimed to have been definitely proved.

A SLIGHT increase in the death-rate from accidents and a small reduction in the injury rate occurred in the stone quarrying industry of the United States in 1926 as compared with 1925. The death-rate, based upon a standard of 300 days of exposure to risk, was 1·87 per thousand employees, as compared with 1·78 in the preceding year. The injury rate was 160 per thousand, as against 170 in 1926.

IT is claimed that the vehicular tunnel which is being constructed across the estuary between Oakland and Alameda, California, is the largest in diameter of its kind. It is being built of reinforced concrete tubes 37ft. in diameter by 203ft. long. The tubes are built in a dry dock and floated out into position, where they are sunk into a previously dredged trench in the bottom. The total length of the tunnel will be 2436ft.

AN interesting method is to be used in the Ruhr district to store the electrical energy not required during night shifts, holidays, &c. A large reservoir is to be established in the hills at Herdecke for storing water. All the available surplus current is to be used for driving pumps which will lift water up into the high-level reservoir. The water power thus stored is to be used to drive turbines to assist the generators during the day shift, and more especially to enable them to deal with any peak loads.

IN a reminiscent article on diamond mining in the *South African Mining and Engineering Journal*, Mr. David Draper tells how the first steam engine crossed the Orange River in 1870. It was an 8 H.P. portable. Very few people had seen a steam engine previously, and when work was commenced the diggers and their wives and families crowded round the machine anxiously awaiting the start. This was preceded by a shrill blast of the whistle, and the immediate flight of the onlookers, who thought the boiler had burst.

IN connection with the risk of explosion through the use of electric switching gear in coal mines, an account of research regarding the probable magnitude of high pressures which might arise owing to arcing during switching operations or through the blowing of fusible cut-outs, and the conditions of its production, forms the subject of two papers by G. Allsop and R. V. Wheeler, entitled "The Pressures Produced on Blowing Electric Fuse Links" and "The Pressure Produced by Electric Arcs in Closed Vessels." These papers give an account of the two investigations, the methods of research, the apparatus employed, and the results of the experiments.

SUMMARISING the results of his investigations into the production of dust by machine drilling in gold mines, the Transvaal Government Mining Engineer says that as palliatives there are two reasonable alternatives: (1) external water feed direct to jumper on the Holmes or Eagle brass head principle; (2) a water-tube machine with (*a*) ample front head air release ports, (*b*) water tube making neat working fit in piston, (*c*) water tube of sufficiently large bore to allow a flow of 5000 cubic centimetres per minute at 40 lb. pressure, (*d*) water tube entering the jumper 1¼in., (*e*) drill steel with ⅞in. bore throughout, (*f*) drill steel with axial hole carefully gauged and centred at the shank end, (*g*) machine fitted with aligning device such as extra long shanks or Siebert-Warren device, (*h*) adequate lubrication of the rotating chuck.

BREEZE and clinker are, of course, used extensively as concrete aggregates, but at present there is very little information available regarding the fundamental causes of the failures which sometimes occur. Such information as is contained in the literature on the properties of these aggregates and the methods of determining their suitability for building purposes is summarised, however, in a report recently issued by the Department of Scientific and Industrial Research. Preliminary investigations at the Building Research Station indicate that, in general, the important factor determining the soundness of these materials is the completeness of the combustion of the coal in the furnace. It is hoped that the further experimental work will provide definite information on the properties of clinker and make it possible to evolve reliable tests for its suitability as a concrete aggregate.

THE practical method of testing for fire-damp in coal mines by means of the "cap" it produces on the flame of a safety lamp still holds, says the Board of Trade *Journal*, the field for convenience and accuracy. Testing for gas, and estimation of the amount present, can be satisfactorily carried out with any well-designed flame safety lamp, but lamps of different types introduced into an atmosphere containing a given amount of fire-damp do not necessarily show the same height and character of cap. In consequence a fireman accustomed to a particular type of lamp might be seriously at fault in his estimation of fire-damp were he to test with another type. A photographic method of reproducing flame caps pictorially for the instruction of firemen and deputies has been developed and is described in a paper by C. S. W. Grice and D. W. Woodhead, entit'ed "The Estimation of Fire-damp: Flame Caps" (afety in Mines Research Board Paper No. 37, H.M. Stationery Office, Adastral House, Kingsway, London, W.C. 2, price 1s. net). The paper is accompanied by coloured reproductions of the caps shown by two very different types of lamps, both in wide use in the industry, in atmospheres containing various percentages of fire-damp.

Miscellanea.

A NEW seam of coal has been struck at the Brynna Wood Colliery, Llanharan. It is 6ft. 3in. thick.

AN aerial survey is being carried out with the object of finding if the river Zambesi is navigable through its upper reaches in Barotseland.

ARRANGEMENTS are being made by the local Chambers of Commerce for the thorough investigation of the oilfields of the Sinkiang province of China.

ACCIDENTS in the metal mines of the United States amounted during 1926 to 3·47 deaths per 1000 men employed, as compared with 2·99 in 1925.

SOME coal mines which have been discovered in the Hsi-an Prefecture in the Tungshan district of Manchuria, are to be exploited at a cost of about £600,000.

THE production of refined copper in the United States during last year amounted to 1,159,000 short tons, that of lead was 807,000 tons, and of zinc 588,000 tons.

AN aerial survey of 20,000 square miles of country near the Congo-Rhodesia border is being carried out, and already more than half the country has been photographed.

AN experimental plant for the treatment of coal by the Bergius process is being put to work in the Transvaal by the Transvaal and Delagoa Bay Investment Company.

IT is proposed to put up a factory for the production of lithopone near Port Arthur, Ontario, and to use for the purpose the barium sulphate deposits on Jarvis Island.

THE borehole which is to be put down at Axholme, near Epworth, Lincolnshire, for the South Hetton Coal Company, is to be bored by the Foraky Company of Doncaster.

A STEAMSHIP recently brought a cargo of coal from India to a North-East Coast ironworks and then sailed for Rotterdam to load a cargo of semi-finished steel to go to the Tata Ironworks in India.

SOME emerald crystals as large as 2in. long by 1¾in. in diameter have been discovered at the new workings near Somerset, Transvaal. They were found at a depth of only about 10ft. below the surface.

THE bridge which it is proposed to construct across the river Tees at Newport will give a headroom for navigation of 160ft. There is, however, some discussion as to whether the main span should be 200ft. or 250ft.

THERE has been a further rise of the water in the mines of the Tipton district. In the main Moat pound the water is at the highest level recorded since the cessation of pumping, being 356ft. 9in. above the floor of the thick coal.

WHAT is said to constitute a record in steel work has been created at the Clydebridge Steel Works, Cambuslang, where a total of 6532 tons of steel plates rolled by the universal three-high mill has been turned out in an ordinary working week.

THE Port Downie Ironworks, Camelon, Falkirk, are to be extended at a cost of £30,000. The proposed additions comprise a new building, which will consist of a ground floor and two storeys above, each of the three floors covering an area of 1800 square yards.

AN exhibition indicating the possible utilisation of overseas Empire timbers has been opened at the Imperial Institute. The exhibition is the second of a series intended to attract attention to the resources of the Empire, and will remain open until April 30th.

A PROPOSAL has been put before the local authorities in Lancashire for spanning the estuary of the river Ribble with a bridge near Blackpool. The bridge would have two decks, one for vehicular traffic and the other for a species of tramway. It would be 2½ miles long, have a navigation span of 600ft. and provide a headroom of 85ft.

DURING 1927, 608 ships of an aggregate net registered tonnage of 1,989,553 tons used the Middlesbrough dock, compared with 568 vessels and 1,760,452 tons in 1925, and 634 vessels and 1,464,091 tons in 1913. The average n.r.t. of ships entering the dock has increased from 2309 in 1913 to 3099 tons in 1925 to 3272 tons in the past year.

BETWEEN January 1st and December 11th, 1927, the record tonnage of 1,151,923 tons of iron ore was taken from the mines of Newfoundland. Production was confined entirely to the Wabana mines on Bell Island. Shipments totalled 1,333,622 tons, of which 800,000 tons went to Germany, 61,030 tons to the United States, and 472,592 tons to the furnaces of the Dominion Iron and Steel Company, Sydney, Nova Scotia.

A COMPANY which has been operating a coal mine in the south of Tasmania has, according to the *Industrial Australian*, made a somewhat unique offer to its employees. The company, after spending £100,000 on the surface plant, came to the end of its resources, and the mine was closed down on September 19th. There are fifty families dependent on the mine, which contains a seam of coal 4ft. 10in. thick, and the company has offered the property to the miners to work on a co-operative basis. It is proposed that the men should work the mine at the recognised wage rates, and sell the coal to the company, and that any profits should be distributed periodically in dividends to the men.

A PANEL of engineers has now been appointed by the Automobile Association to conduct the necessary tests in connection with the motor cycle silencing scheme, recently inaugurated by the Association in conjunction with the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd. The following engineers constitute the panel:—Hubert C. Clark, A.M.I. Mech. E. (chairman), Leslie Hounsfield, A.R.C. Sc., M.I. Mech. E., M.I.A.E., Basil H. Joy, M.I. Mech. E., F. H. Lee, A.M.I.A.E., W. A. Tookey, M.I. Mech. E., M.I.A.E., E. Bradford Ware, M.I.A.E. The efficiency of the silencing devices will in every case be the subject of thorough tests and subsequent certification by this panel of engineers appointed by the Automobile Association. Certificates of efficiency will then be issued by the A.A. in respect of current models of motor cycles, submitted by the manufacturers to the Association for examination.

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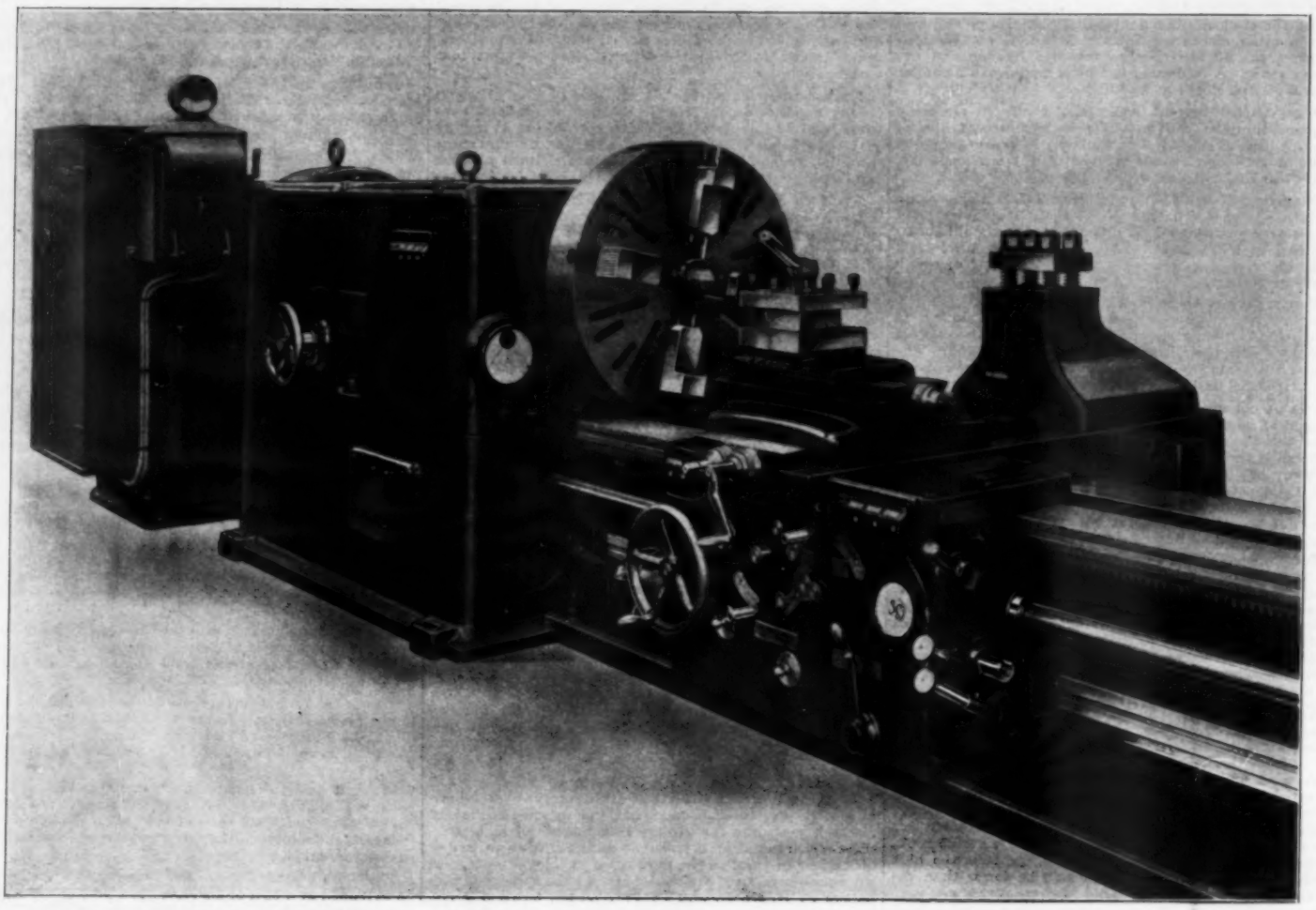
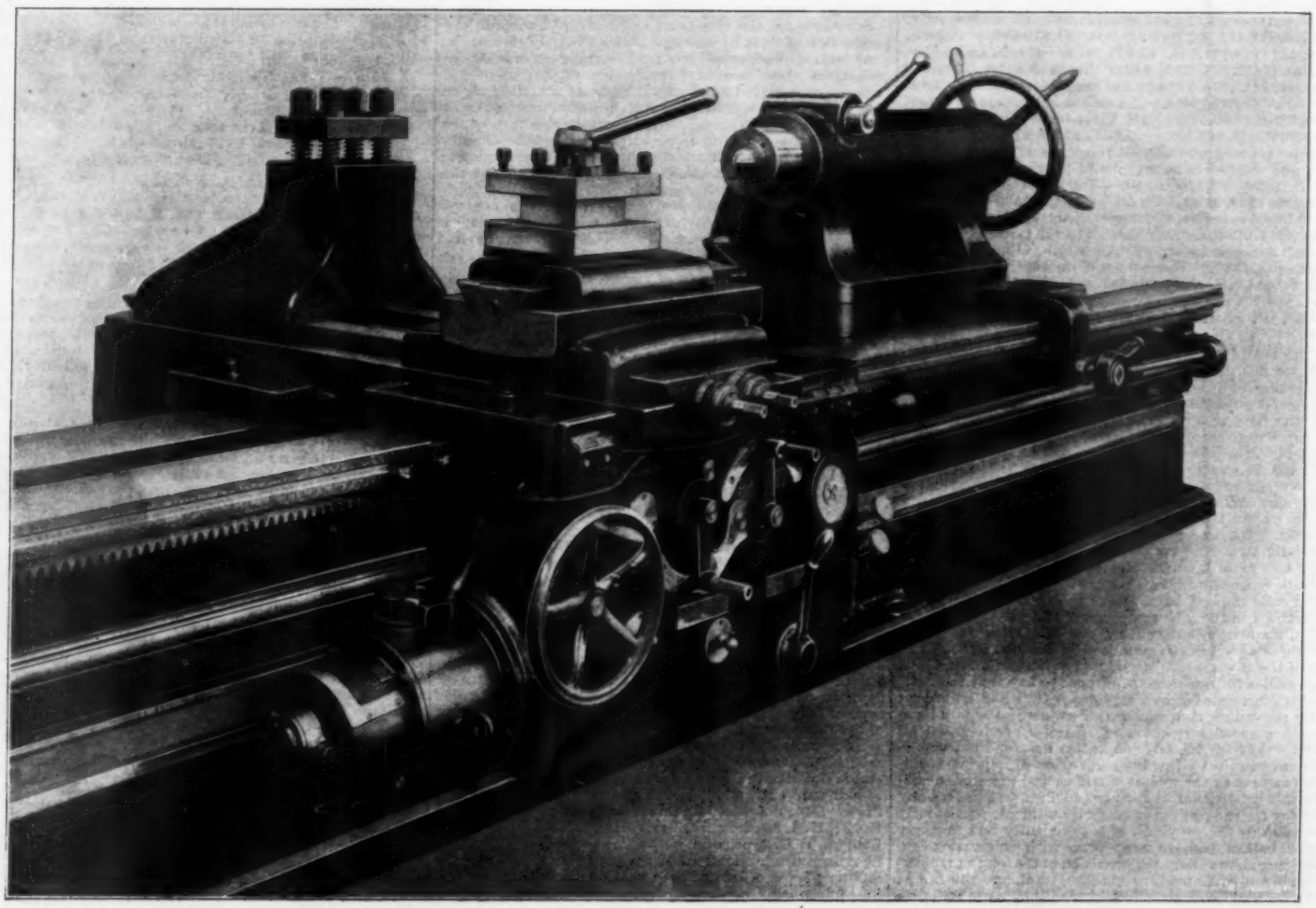
(*For description see page* 166)





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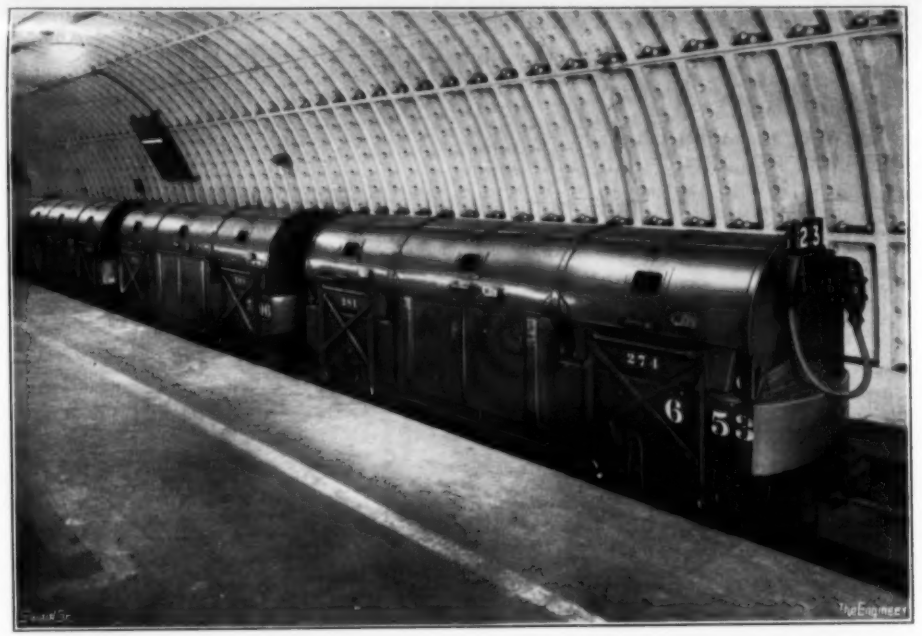

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DEATH.

On February 4th, 1928, at a nursing home in London, GEORGE CHALMERS, M. Inst. C.E., of Southcliff, Lyme Regis, late general manager, St. John del Rey Mine, Brazil, aged seventy-one.

THE ENGINEER.

FEBRUARY 10, 1928.

The 10,000-Ton Cruiser.

THE American Naval Bill now before Congress provides, *inter alia*, for twenty-five cruisers of the 10,000-ton class, additional to the eight similar vessels already under construction. In all, therefore, the provision of thirty-three of these large and formidable ships is contemplated. Under the British programme submitted to Parliament in 1925, it was proposed to build sixteen cruisers, nine of which were to be of 10,000 tons and seven of 8000 tons. Five 10,000-ton ships had been started in the preceding year, and the Australian Government had ordered two ships of corresponding type. Had the 1925 programme been carried out in full, the British Empire eventually would have had sixteen cruisers of the 10,000-ton class, or not quite half as many as the United States proposes to build. Recently, however, the British Government announced the deletion of one 10,000-ton and one 8000-ton cruiser from the Navy Estimates for the current financial year, and it has since been stated that another cruiser is to be dropped in the coming year. Apparently, therefore, we are to have only fourteen cruisers of the heaviest type, even if no further cuts are made in the five-year building programme, which extends to 1929–30. It is widely assumed that the Government has reduced the cruiser programme for reasons of economy, and also with a view to giving the other Powers a lead in the matter of naval limitation. Although both motives may have been present we should not be surprised to learn that the decision was influenced in no small measure by the advice of Admiralty experts. It goes without saying that the Board of Admiralty, charged as it is with responsibility for the safety of our world-wide communications, is anxious to secure an adequate quota of cruiser tonnage. It does not follow, however, that the Admiralty regards the 10,000-ton cruiser as the best type of ship for this purpose. We have reason to believe that British naval opinion is by no means enamoured of the type in question, which is regarded as a hybrid, owing its development to political rather than to scientific or purely naval impulses. Prior to the Washington Conference, cruising ships—apart from the battle-cruiser, which is in effect a fast capital ship—were divided into two classes, viz., the armoured cruiser, which had already become obsolete, and the protected cruiser. The latter was the true cruising ship, and its cardinal function, so far as the British Navy was concerned, was the protection of trade.

At the date of the Conference almost all our protected cruisers were ships of less than 6000 tons, mounting 6in. guns. The only important exceptions were the five units of the "Raleigh" class which had been designed during the war for the specific purpose of hunting German raiders. Moreover, the great majority of foreign cruisers were also below 6000 tons, the largest ships of this class being the ten American "Omahas," of 7500 tons, which, however, still retained the 6in. gun. Yet the Conference, for reasons never fully elucidated, decided to fix the maximum displacement of future cruisers, not at the then prevailing average of 6000 tons or less, but at the needlessly extravagant figure of 10,000 tons. Nor was this all. By adopting the so-called "standard" measure of displacement, which excludes fuel and feed water, the way was left open for constructing cruisers which are as large as the big armoured cruisers of the "pre-Dreadnought" era. It is not too much to say that the effect of the Washington Treaty has been to double the tonnage of the cruising ship. At the same time its aggressive power has been proportionately increased by the substitution of 8in. for 6in. guns. The result is that ships designed up to the maximum limits of displacement and armament authorised by the Treaty are virtually small battle-cruisers, whose true *métier* is to fight in squadrons. It is plain to see that the American experts who are believed to have sponsored these limits regarded the cruiser essentially as a fighting ship, and gave little heed to her function as a guardian of commerce, in which light she has always been viewed by British opinion. On the other hand, no explanation has been afforded of the failure of our delegates at Washington to resist proposals which were so manifestly prejudicial to the cause of naval disarmament in general and to this country in particular. The advent of the 10,000-ton, 8in. type has rendered nine-tenths of our existing cruiser tonnage obsolete. Sooner or later the wastage will have to be made good, and a decision must therefore be reached as to what type of cruiser we shall build. Are we blindly to follow the lead of the opulent United States and lay down nothing but 10,000-ton ships, or shall we adopt a smaller type of vessel better suited to our straitened means? If we pursue the former policy it is quite certain that we shall never have enough ships to guard the vital trade routes, simply because we cannot afford to build a large number of vessels costing £2,000,000 or more apiece. It seems to us, therefore, that British interests would be served best by a modified type of cruiser, smaller in tonnage but equal in speed and gun calibre to ships of the Treaty class. Vessels, such as H.M.S. "York," of 8400 tons and six 8in. guns, should answer all reasonable requirements. If America cares to go on building 10,000-ton ships, that is her affair, but a time will certainly come when her taxpayers will revolt against fantastic expenditure on warships that are demonstrably superfluous. No real case has been or can be made out for the huge programme which Congress is asked to approve. If it is not competitive, that is only because Great Britain and the other Treaty Powers have too much sense to be drawn into an utterly futile shipbuilding contest. That would be to play right into the hands of the "big Navy" propagandists in Washington, who are seeing potential enemies where none exist. We believe, with Lord Grey of Fallodon and the First Lord of the Admiralty, that British interests do not call for a "reply" to this singular American project. As Mr. Bridgeman said in a speech last week: "It is inconceivable that either America or Britain should entertain aggressive, warlike ideas in these days. Let us go quietly on with what we think is necessary for ourselves." America, for the time being at least, pins her faith to overgrown cruisers, estimated to cost £3,400,000 each. Vessels costing half that sum should suffice for British requirements, which are determined mainly by the problem of commerce protection. Besides its exorbitant cost, there are other and even stronger objections to the 10,000-ton cruiser. Owing to the combination of very high speed and powerful armament, it is impossible to give such ships adequate protection against the various forms of

attack to which they will be exposed. While there are minor differences in the ships of this type already laid down at home and abroad, the basic features are the same. There is a hull about 600ft. long and 70ft. broad, machinery developing at least 80,000 H.P., a main armament of not less than eight 8in., 50-calibre guns, with numerous secondary pieces and torpedo tubes; elaborate equipment, which includes aircraft and its launching gear, and, last but not least, accommodation for a crew of about 700 officers and men. Omitting fuel and boiler water, a ship of this type must not displace a fraction over 10,000 tons. Obviously, therefore, the margin of weight left over for protection is exceedingly small. In some designs a narrow belt of 2in. or 3in. armour is provided. It would serve to detonate shell which otherwise might pass through the ship without bursting, but its protective value is nil. Other vessels have, instead of belt armour, a vaulted steel deck over the vital parts, but here again the thickness is not sufficient to keep out projectiles of medium calibre or heavy air bombs. As the machinery and magazine spaces together occupy at least five-sixths of the total length of hull, it is clearly impossible to give anything like real protection to the whole of this vulnerable area. Consequently, the gun turrets, ammunition hoists, magazines, engine-rooms, boiler compartments and the water-line itself, are all exposed to gunfire, and a direct hit almost anywhere along the hull might cause serious, if not fatal, damage.

As for protection against torpedoes and mines, we shall quote the opinion of Sir George Thurston, the well-known constructor, on this type of vessel, which he dealt with in "Brassey's Annual" for 1925: "The interior of such a cruiser is so fully occupied by boilers, machinery and magazines that it is not humanly possible to provide by bulkheads, water-tight compartments or other methods of underwater protection, immunity from torpedo or mine attack. Therefore, while in the interest of ordinary safety it is advisable to keep the vitals as far away as possible from the sides and to subdivide to the fullest possible extent, it must be recognised that the explosion of a large mine or of a torpedo with a powerful warhead would, in the majority of cases, utterly wreck and destroy the vessel." In time of war these ships would have to face the attack of 8in. guns, firing 250 lb. high-explosive projectiles at ranges up to 22,000 yards, and of air bombs, torpedoes and mines much more powerful than any that were employed in the late war. Against such weapons they have no real protection. Proportionate to their size they are the most vulnerable warships ever built. It is difficult to see how they could survive a determined attack, the success of which would involve not merely the loss of a costly ship, but the lives of the 700 people crowded into her fragile hull. No wonder, then, that naval opinion in every country save the United States favours reversion to a more reasonable type of cruiser. Great Britain and Japan have already introduced smaller designs; Italy, after building two 10,000-ton ships, has decided to build no more; and France seems likely to follow suit. It remains to be seen for how long the hybrid Treaty type will retain its popularity in the land of its birth.

The Development of Inventions.

ON one or two occasions of late we have felt ourselves obliged to refer to the ill effects which the practice of buying licences from foreign manufacturers is having upon the prestige of British engineers in foreign lands. We have shown that in turbine design, oil engine design, and even in steam locomotives, our indebtedness to foreign inventors is high. That we are not alone in regretting this indebtedness, we need hardly say, but we could ask for no better support than that given by Professor Hawkes in the recent Thomas Lowe Gray Lecture at the Institution of Mechanical Engineers. Professor Hawkes was speaking of oil engines, and said: "After the war there was a greater demand for marine oil engines, and I think it is to be regretted that so few British firms developed engines of their own designs, especially in view of the fact that knowledge of the subject had then been widely disseminated. It may be that initiative in the direction of independent development was influenced by the high cost of experimental work, and the desire to produce engines for the market as soon as possible. . . . It is true that the construction of experimental units is costly, but the need for experiment and research was never more important than it is to-day."

Whilst Professor Hawkes was able to add that there is some improvement in this respect, and that more firms are now in possession of experimental plant, the fact remains that, in certain lines of engineering production, British engineers still show a tendency rather to utilise the pioneer work of others than to engage in it themselves. The reason for this attitude is not far to seek. We have but to consider, on the one hand, the costly nature of experimental development, and, on the other, the difficult, often parlous, state of many engineering firms at the present time. We could without much difficulty place our finger on half a dozen different inventions of prime importance which might be brought to fruition were sufficient money available for their further development. But when manufacturers are put to it, even to make both ends meet, when only by great struggles they can pay their debentures and preference shares, and when there are no dividends for the ordinary shareholder, it is not only impossible to devote funds to experimental work, but an investing public cannot be found. Furthermore, the strictly conservative policy of our banks, and, as a rule, their total lack of comprehension of technical matters, causes them to withhold those advances to industry which are often made by the banks of other lands. But we are not prepared to say that lack of money is the sole cause of the predisposition to accept foreign inventions; evidence of its existence were not wanting at a time when money was more easily procurable than it is now. The business element takes a stronger and stronger position in engineering production as the years go by, and business has but little national sentiment. If it sees the means of avoiding expensive experiments by acquiring foreign licences, it is likely to adopt them, rather than encourage British designs, even though they hold out prospects of ultimate success. Such a policy, if not actually short-sighted, lacks that length of vision which means so much to industry. By the expenditure of money on development, not only would the payment of licence fees be avoided, but the progressive manufacturer would, in his turn, become the recipient of fees from foreign firms. Yet, after all, it is lack of money more than anything else that is responsible for that want of national enterprise which we are discussing. It may be said without fear of contradiction by any who have devoted serious study to the matter, that unless a firm can make a fairly steady ten or twelve per cent. on its capital, it will not be in a position to embark upon costly developments. If it has to think twice about every hundred pounds that it spends, it cannot be expected to enter into a research, however hopeful it may appear, of which the end and final cost cannot be seen. That elementary fact is not infrequently overlooked by economists who declaim against large profits, and it is forgotten or neglected by boroughs which impose excessive rates upon factories and by Chancellors who load industries with taxation. We can no more expect an engineering firm to develop if it is borne down by the weight of taxes and rates than we can expect a householder to keep his property in decent repair or a farmer to improve his farm if he is barely able to meet the rent. Development and progress can only be paid for out of actual or potential excess profits—generally the former. It seems not improbable that the burden of Excess Profit Duty, which to this day lies heavily upon many engineers, is responsible in large part for the fact that less progress is being made in this country than, for example, in the United States where there is unlimited money. But it is not the sole cause. Germany and Switzerland are no more wealthy than we, and we must regard their progressiveness as rather the fruit of an intelligent economic policy which enables firms to earn a surplus profit than to national wealth. We are overburdened with social taxation and excessive rating at the very moment when foreign competitors are most active in their opposition. With improving trade, we shall no doubt see a greater tendency to spend money on British inventions and improvements, but all efforts in that direction will be thwarted if such increased profits as the manufacturers see the means of acquiring are immediately absorbed by further demands upon their purses.

The development of designs and inventions is of little, if any, less importance to the progress of industry than research into fundamental principles. But because its value is reserved—by such protection as patents can give—to certain persons, it does not enjoy either the reputation or the financial help that is given to research. That is inevitable, and we do not for one moment suggest a change in that respect. It should, however, be recognised that a great deal of the work that is called research—particularly in America and Germany—is really no more than the development of designs and inventions. That is to say, it has but little to do with scientific discovery; its chief object being to apply science in a manner fitted to workshop conditions. This fact should be recalled when unqualified statements are made as to the number of persons employed in, and the vast sums of money spent upon, "research" in other lands. A relatively small number of those persons is engaged upon what we should call research. The greater number and the greater part of the equipment are employed on experimental inquiries of a very practical kind; partly to make a new invention work at all, and partly to reduce its parts to forms that are convenient for manufacture. With a few notable exceptions, work of that kind is done in the ordinary drawing-offices and workshops of our engineering firms. It is, then, not dignified by the name of "research," but it is just as important, just as valuable, as if it had been carried out in a Research Laboratory. Unless we can continue to do it, by one method or the other, we must lose ground or continue to draw our inventions, at the cost of licences, from foreign countries and so save, for the time being, our trade at the cost of our prestige. The enterprise which once characterised British engineers is by no means lost; it is still with us, but it cannot reveal itself whilst the money for costly experiments is not to be found.

Institution of Mechanical Engineers.

NORTH-WESTERN BRANCH.

AT a meeting of the North-Western Branch of the Institution of Mechanical Engineers, held on Thursday, February 2nd, Dr. P. Telford Petrie presented the Fifth Report of the Steam Nozzles Research Committee. Professor Watkinson presided.

The discussion was opened by Mr. K. Baumann, who said that the work of the Committee had had a great influence on turbine development. The results might not be perfectly accurate as regarded absolute values, but they were reasonably accurate as far as relative values were concerned. The realisation of that had been largely responsible for the great interest which had been shown by turbine builders. As a result, a nozzle tester of the same type had been installed at Trafford Park, where it had been in operation for several years. A similar tester was employed by a well-known firm in Sweden. At Trafford Park they had made tests to find out the effect of size on actual turbine nozzles. For that purpose they had made three sets of nozzle blocks, different in size, but otherwise identical. They had expected that the larger nozzles would be the more efficient, and that proved to be the case.

Mr. Baumann showed by means of a slide the design of these nozzles, and explained that a flapping effect was caused by grooves cut along each side of the nozzles.

Mr. Norman Elce said that the function of a nozzle was twofold:—It had to convert heat energy into velocity, and it had also to direct the jet in a particular direction. The tests showed that heat energy could be converted into velocity with almost no loss, but that whenever curvature was introduced the losses increased very rapidly. Mr. Elce showed a slide of tests published by the Committee, and others made by the Metropolitan-Vickers Electrical Company to illustrate his meaning. For a straight jet the energy was less, he said, about 2 per cent., while for the maximum curvature the loss was 11 per cent.

Mr. Benjamin Hodkinson said that it was important to have checks wherever possible. There were two thermometer pockets for initial temperature, and presumably the platinum thermometer was checked against a mercury thermometer. There were two tappings for initial pressure, so that a check was possible. Certainly in the high-pressure tests a check was made by the differential gauge. The cage weighing lever would scarcely change. There remained the quantity of condensate. A valuable check would be to interpose a measuring orifice or nozzle somewhere in the steam line. A thermometer and pressure gauge provided a usefully accurate estimate of steam quantity.

The actual specimens tested should have unquestionable uniformity of workmanship. The Committee's 1¼in. high chamfered nozzle with a 3/1 throat seemed better, if anything, than its old one 2in. high, but the thin plate one 1¼in. high, with 3/1 throat, did not seem to be better. The 0/1 throat seemed to be noticeably worse. One would have thought, continued Mr. Hodkinson, that all the 1¼in. high nozzles would have been slightly worse than the corresponding 2in. nozzles.

The superheat had hitherto not been controllable, though it was stated on page 316 of the second report that the initial steam tem-

perature could be maintained steady to within 1 deg. Cent. for half an hour. Variation of superheat had provided interesting discoveries, however, and no doubt a greater range could be got by coupling the superheater to Dickinson-street instead of only to Bloom-street, which had supplied steam at a lower temperature. It was indicated on page 769 of the Fourth Report that the effect of increase of temperature was not only to lower the efficiency, but to move the curve bodily to the left. That needed careful substantiation, since the curve shapes possessed few features for identification, and if it should turn out that, in the changes of temperature and pressure range, the various maxima and so forth occurred at velocities which depended, say, on the critical velocity, then since critical velocity increased with temperature, the effect would be in the opposite direction to that stated; that was, increase of temperature would move the curve to the right. One would have expected the curve to have moved to the left if the losses were appreciably affected by Reynolds' function.

Soon after the publication of the Committee's last report, they had tested one of the turbines in their experimental department at Metropolitan-Vickers at varying superheat. It was a ten-stage machine, and the steam temperature in all comparisons had been so high as to ensure that there was still from 70 deg. to 170 deg. Fah. superheat at exhaust. The conclusion had been confirmatory of that of the Committee, that higher superheat gave greater losses but the effect was only small in amount.

Higher-back pressures were stated to give the same results as the lower pressures, or at least it was not taken as proved that they were worse; but in presenting experimental results, it was honest to do as the Committee had done, and give the reader the actual points plotted, and to let him form his own opinion about the probable curves or widths of accuracy bands. The impression given by comparing squares with crosses in the two collections 35 and 36 was that higher back pressure gave a lower result. Curve 34 had no points at atmospheric pressure, whilst the half-dozen points on Curve 26A were for a nozzle with very small loss. It was mentioned that the old 0/1 20 deg. thin plate nozzle had been tested at higher back pressures, but the actual test results seemed not to be given in that report. The matter was one which would become clearer as more testing was done, as it would be possible to leave a test nozzle undisturbed and change only the steam condition.

Cage design had been investigated by the Metropolitan-Vickers Company, and by going to such extremes as 8in. and to 0·9in. cage distance, a slight effect had been indicated, as appeared in Mr. Guy's communication, which he—Mr. Hodkinson—had read on Jan. 20th in London. Any errors due to vortices, as described in the valuable paper of Dr. T. B. Morley in 1916, seemed almost completely eliminated in the present apparatus. The radial streams on the plate which in large measure maintained them were buried under the mass of wire netting, and the various further devices, such as a shield under the cage and so forth, which his company was developing, were in the nature of refinements. The Committee had early investigated the conditions outside the cage, and had found no variation of pressure anywhere in the body of the tester of as much as 1/10in. of water. The Metropolitan-Vickers Company had gone over that ground again, and had found a similar result.

Mr. G. E. Bailey said that on the slides which had been shown, in one case the nozzles had been serrated, and the serrations were at right angles to the flow of the steam. One could imagine that condition being brought about by corrosion, but hardly by erosion, and he had wondered whether the Committee had done anything with grooves in the direction with the flow of the steam. Also, had the Committee included in its activities purely the shapes of nozzles from the efficiency point of view, or had it taken into consideration that nozzles on a turbine had to last more than twelve months, and that the initial efficiency was not everything? It was the final efficiency and the length of time that the nozzle would remain efficient that really counted in large units. Had the Committee given any thought to the materials for nozzles, having in mind the fact that it had already thought it sufficiently important to consider the effect of erosion on nozzles?

Mr. F. B. Tucker said that the Committee did not include discharge coefficients in its reports, but they could, of course, be calculated from the data which it did give. At Metropolitan-Vickers they had found that their discharge coefficients gave curves as definite as those of velocity coefficients. Quite apart from the value of the discharge coefficients themselves, they would draw attention to the importance of considering them when drawing curves of velocity coefficients. In scrutinising a series of tests, a test giving a high discharge coefficient and a high velocity coefficient should be checked for a negative error in the adiabatic velocity, and *vice versâ*. Again, if a test gave high discharge and low velocity coefficient a positive error in the measured steam quantity should be looked for, and *vice versâ*. That was clearly so, considering that the adiabatic velocity was in the denominator of both discharge and velocity coefficients, while the measured steam quantity was in the numerator of the discharge, but in the denominator of the velocity coefficient.

While examining the tests on the 1¼in. diameter straight convergent nozzle of Table XLII., for comparison with a test of their own, Mr. Tucker said he had been led to suspect some inaccuracy in some of the results tabulated there. He thought the following corrections would be found to be necessary:—

TABLE XLII.

Test No.	C_m ft./sec.	ϕ instead of	ϕ
8	522·7	101·13	99·97
11	1671·4	99·26	98·88
5	1671·6	99·19	98·06

After making those corrections they could reasonably draw a curve through them, as he showed on a slide.

There were three further points which were open to question regarding the measured steam quantity, two of them giving high discharge coefficients with low velocity coefficients, the other a low discharge with high velocity coefficient. Ignoring those three, the remainder lay very closely round the curve he had drawn, which he contended was more satisfactory than covering all the points with a band.

Mr. H. L. Guy said that one of the criticisms of the Committee's work which had been made in the past had been that in the original experiments, made to establish the validity of the mode of testing adopted by the Committee—that of the impulse plate with a cage above it—the test upon which the Committee had appeared to depend had been carried out first in surroundings on the discharge side of the cage which were different from the surroundings in the actual casing of the tester. Secondly, it had been said that the nozzle which had been used in the test was a very small nozzle. If he remembered rightly, it was ¼in. diameter, and therefore the forces measured might have been very much smaller than they would have been had the test been carried out with nozzles of the area which the Committee had used in its actual researches. Those were perfectly legitimate questions, and until they were answered the door for criticism remained open. They had felt the desirability of investigating that matter a little further, not because they had any reason to doubt the conclusions at which one naturally arrived as a result of the work of the Committee. In fact, it was first a very substantial proof of the general accuracy of the results. Conclusions arrived at with earlier testers by earlier workers—principally tests of the reaction type—had resulted in establishing forms of characteristic curves for an efficiency of nozzle flow which had immediately caused the designers to change the mode of arrangement of a turbine internally in the effort to get higher efficiency. The direction in which the designers had turned had proved to be disappointing, and the results predicted from those earlier experiments had not come about in the actual turbine. The direction in which turbine development had gone as a result of the Committee's work had proved to give the results which had been expected on the basis of the Committee's tests. That, after all, was the most substantial confirmation of the general accuracy of the Committee's work which one could hope to get.

Mr. C. E. Stromeyer said that he had not followed the Research Committee's inquiries, but that one of the speakers had mentioned the different sizes of nozzles in making comparisons. Those experiments were deserving of very close study, but the difficulty was how to study them. He believed that that study could be carried out by considering the reflections which took place. It was not generally known that in an elastic medium any change of motion or position took place immediately. Movements took place as though there were no mass to move. He had had to use that knowledge on one occasion where there had been trouble with the initial pressure in a reciprocating engine. Apparently the pressure which was caused by the slide valve shutting off had travelled the length of the steam pipe, and had then been reflected at the boiler end, and it had just reached the slide valve when it was opening. Under those conditions, one got an excessive initial pressure. If the vacuum wave just reached the slide valve when it was opened, the pressure was too small. That had seemed to him to explain the reason for the discrepancy which had been noticed in the engine. With regard to the nozzle space, one ought to put a ridge at the bottpm of the nozzle. With the steam going through there would be a reflection which would meet the steam coming up at the top and would create an artificial resistance. If the pipe were straight continuously one could only begin at the top end, but with the short nozzle there was an image of the end of the nozzle at the top end. That reflection or image would be more important and far more complicated in the grooved nozzle, but it might help in the discrepancies which were discovered.

Dr. Petrie replied briefly to the discussion. He said that they particularly welcomed legitimate criticism, because that, after all, was what they were there for. Work of the kind carried out openly by the Committee and under a large Institution like the Mechanicals was bound to be as public as possible. He looked forward to studying Mr Hodkinson's remarks in more detail when they were in print. The criticisms seemed to be very valuable and would be of help to the Committee. With regard to the question of superheat, they were now undertaking tests to find out the effect of superheat on a nozzle. That had been done by Metropolitan-Vickers, but the Committee had only done it in an indirect way. It now formed part of its future programme.

With reference to Mr. Hodkinson's remarks about angles, Dr. Petrie said that the Committee had taken efflux tests from its own point of view. It had chiefly been interested to determine how much the jet deviated from the normal in order to find how it affected the settings in the cage. That was why in some cases angles had been used which did not appear to be experimentally correct. He believed that a good deal of work could usefully be done in that connection by others. Mr. Bailey's suggestion of longitudinal instead of transverse serrations was valuable; the Committee was undertaking further work of that nature at the present time. The question of materials had not been considered, but that suggestion might receive due consideration in time. The Committee's present programme was extensive, and naturally it had to pick and choose the work that seemed to be of most general interest.

Dr. Petrie, in conclusion, mentioned the names of Mr. Ashworth, Mr. Barton, Mr. Burke and Mr. Oakden, who had all contributed as research assistants to the very considerable work involved in the actual carrying out and calculating of those tests.

SIXTY YEARS AGO.

NAPOLEON III., Emperor of the French, is appraised to-day as an amiable dabbler in a wide range of subjects appealing to his interests, affecting his country's welfare or designed to strengthen his position on the throne. He was the chief moving spirit behind the Great Exhibition held in Paris in 1867. He competed with manufacturers and inventors in the designing of a French breech-loading rifle that would answer the sudden challenge of the German needle gun. At one time he was engaged writing a history of artillery; at another, on proposing plans for cutting a canal across the isthmus of Panama. When butter became scarce in Paris, it was he who suggested and encouraged the manufacture of the artificial product which is now known as margarine. From an essay on pauperism he turned with facility to discuss the sugar question. But if he was a dabbler, it is hard to find anything ridiculous in his versatility. His reign was a misfortune for France, but it was not because he lacked natural ability. Had he been born other than the nephew of the first Buonaparte, he might have become one of France's distinguished scientists. In the earlier part of his life, at any rate, he was endowed with the true scientific spirit, which impels its possessor to the pursuit of knowledge at all times, even in the most adverse circumstances. Sixty years ago his hold over the country was rapidly waning. He had only two more years to reign before he was rushed by his advisors into war as the only means of saving his throne. There is more, therefore, than its mere intrinsic interest in a short article in our issue of February 7th, 1868, in which we gave in his own words an account of some experiments on the Voltaic pile which he had conducted in 1843. We see him in the fortress of Ham, on the river Somme, half-way through the six years of imprisonment which were the only outcome of his landing at Boulogne in August, 1840. He had still five years and more to pass before the turn of the tide made him, first, President and then Emperor of his country. In the document which we reproduced—a document apparently which had been omitted from his collected works—we find him writing to Arago describing his investigations into the source of galvanic electricity. The letter shows him conversant with the work and opinions of Davy, Volta, Faraday and Daniels, and with the theory of "the ordinary electric machine." He adheres to Faraday's view that the only cause of galvanic electricity is the chemical decomposition of the metals of the pile and argues that the elements of the pile need not be dissimilar metals. He seeks to, and succeeds in, proving his theory experimentally in a manner which for its clearness subsequently calls forth the commendation of the French Academy, which, however, records that the Prince Napoleon had been preceded by Monsieur Becquerel in the construction of a pile composed of elements consisting of only one metal. It is, however, the human rather than the scientific interest of the Prince's letter to Arago that appeals to us to-day. Near its end we receive a glimpse of the high scientific spirit that was in the man. He desired to measure the strength of the currents produced by the different piles with which he experimented, but was checked because he had not a galvanometer. He therefore set about making one, but failed, because the magnetised needles were always deviated by the attraction of the iron bars surrounding his windows. That is the only indication in the letter that he was a prisoner.

BOOKS RECEIVED.

Kokerei- und Gaswerksöfen. By L. Litinsky. Halle (Saale): Wilhelm Knapp, Germany. Price 21 marks net.

Principles of Mechanism. By F. Dyson. London: The Oxford University Press, Falcon-square, E.C. 1. Price 12s. net.

Mining Engineer's Handbook. Second edition. By Robert Peele. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 50s. net.

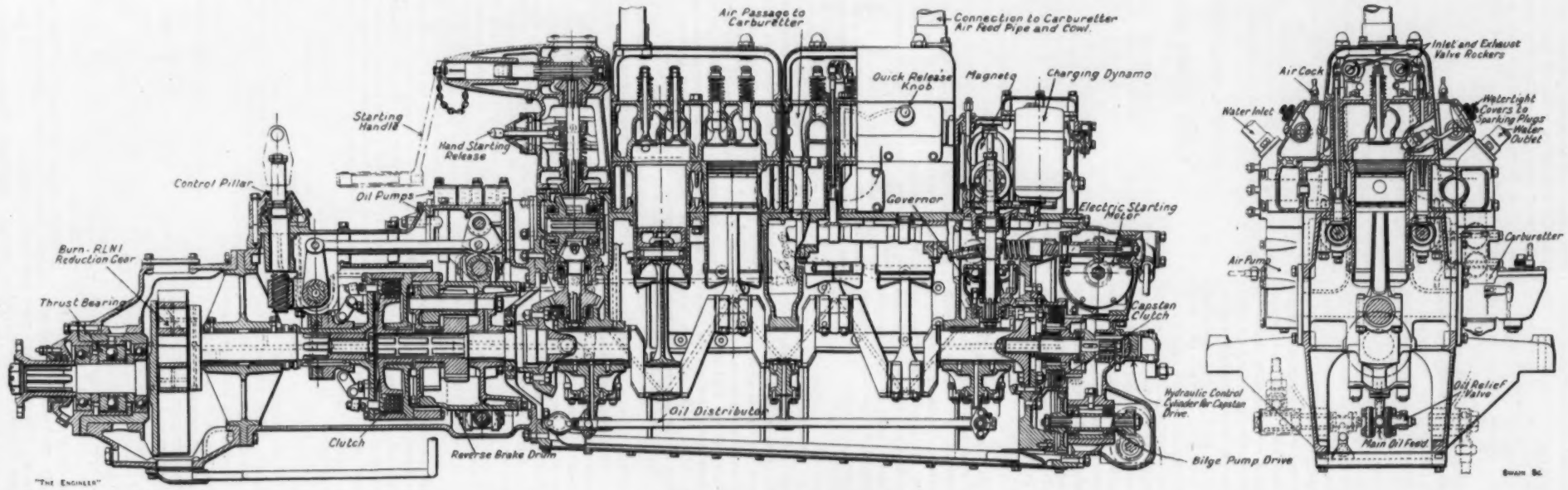
Britain's Industrial Future: Being a Report of the Liberal Industrial Inquiry. London: Ernest Benn, Ltd., Bouverie House, Fleet-street, E.C. 4. Price 2s. 6d. net.

Proceedings of the American Society for Testing Materials. Vol. 27. Part I., Committee Reports and New and Revised Tentative Standards; Part II., Technical Papers. Philadelphia: The American Society for Testing Materials, 1315, Spruce-street, U.S.A. Price 6 dollars each part

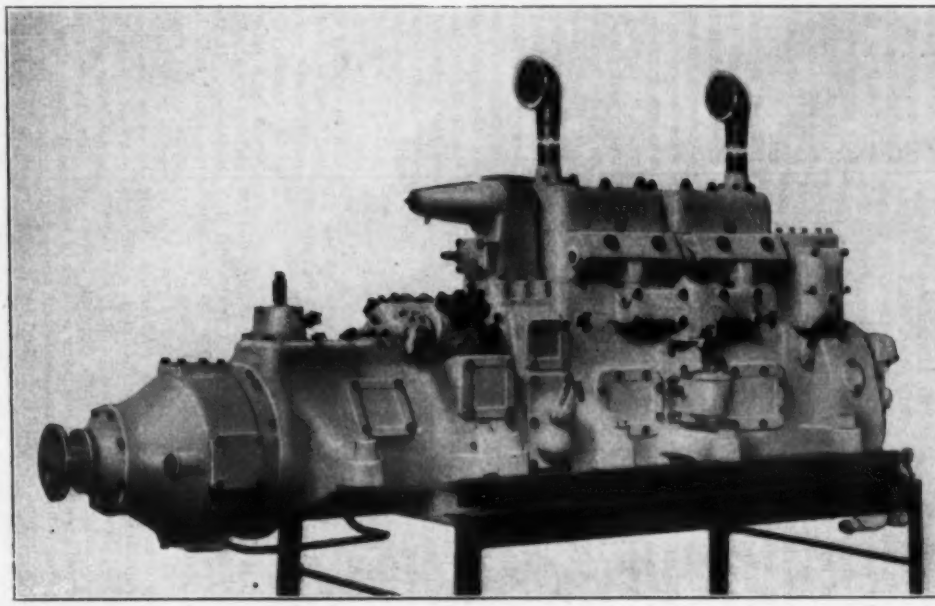
A COMPLETELY SUBMERSIBLE PETROL ENGINE FOR LIFEBOAT SERVICE

THE WEYBURN ENGINEERING COMPANY, LTD., ELSTEAD, ENGINEERS

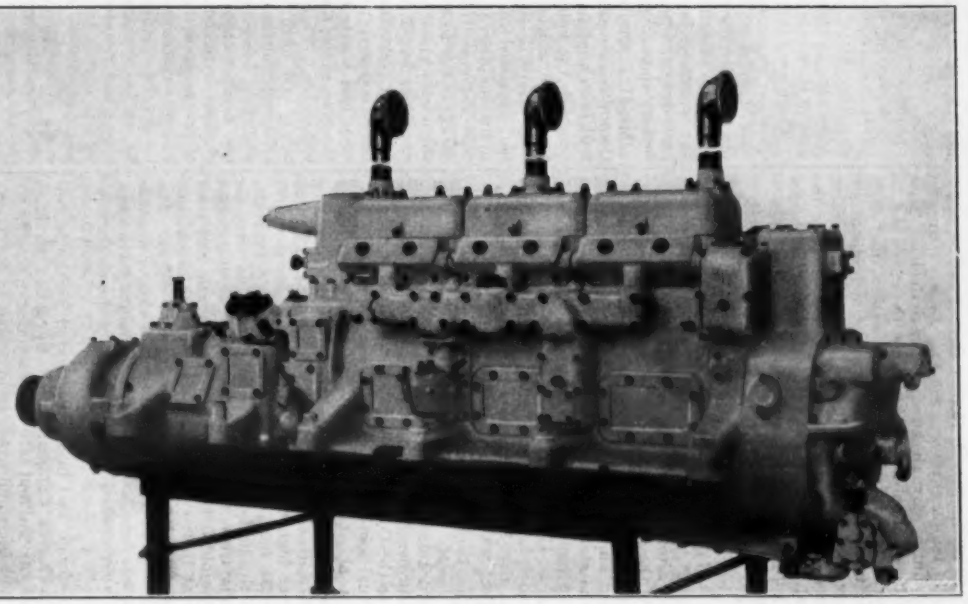
(For description see opposite page)



SECTIONS OF FOUR-CYLINDER ENGINE



FOUR-CYLINDER ENGINE



SIX-CYLINDER ENGINE

A Completely Submersible Lifeboat Engine.

WE recently had the opportunity of inspecting at the works of the Weyburn Engineering Company, Ltd., of Elstead, Surrey, several examples of a completely submersible "C.E." type petrol engine which has been specially designed by the Royal National Lifeboat Institution to meet the arduous duties of lifeboat service. The type of engine which we are about to describe is entirely new in its design, and it differs in several important respects from the previous "D.E." type lifeboat engine, which, it may be recalled, was fully described and illustrated in a special Supplement in THE ENGINEER of December 22nd, 1922.

Some Features of the Design.—The primary object for which the new engine was built was to increase the reliability of the machinery installation of a lifeboat by dividing the total propelling power required into two separate self-contained units so that a double factor of safety would be secured. Another end in view was to reduce the size of individual parts, such as cylinder heads, &c., which might call for removal during inspection work, so that they could be conveniently lifted by a single attendant. Coupled with this idea an endeavour was made so to fashion individual details that the same elements could be assembled to form, without other special parts, either right-hand or left-hand engines, with inward or outward turning screws, and with the engine controls arranged either inboard or outboard as required. The engine was also made completely submersible so that it could be started and operated under water continuously, so long as the water did not reach the level of the raised inlet pipes for the air feed to the carburetter.

Two sizes of engines, one with four and the other with six cylinders, have been constructed. They are illustrated by the engravings on page 162. In both sizes the cylinders have a bore of 4¼in. with a stroke of 5½in., and at 1200 revolutions per minute the rated service outputs of the two units are 40 and 60 B.H.P. respectively. By means of a two-to-one reduction gear a standard propeller speed of 600 revolutions per minute is obtained. The engines are finished in white enamel, the bolt and screw heads being picked out in black. This finish has, we understand, been found very satisfactory under service conditions, and encourages general cleanliness in the engine-room.

Engine Crank Case and Running Parts.—From the sectional drawing of the four-cylinder engine reproduced on the top of the opposite page it will be seen that the crank case casting, which is made in "Wilmil A" sea-water-resisting aluminium alloy, carries the three main bearings for the crank shaft, as well as four bearings for each of the two cam shafts. At both the forward and after ends of the crank case circular facings are provided for the attachment of the reversing gear, the capstan drive, and the electric starting equipment.

The casing is extended down well below the crank shaft bearings, so that an oil well is formed in which the oil distributor and its connections are housed. Provision is made to admit the crank shaft through a large aperture cast in the bottom of the casing, the opening normally being closed by a sump plate. An alloy steel crank shaft with three main bearings, each 2½in. diameter is used. The length of the two outer bearings is 6¼in., while that of the centre bearing is 3in. The crank pins are 2¼in. in diameter and have a length of 3in. The webs are machined all over and the shaft is balanced. Drilled holes in both the shaft and webs form a central oil passage, which communicates with all bearings and is supplied with oil from the distributor connections attached to the underside of the bearing caps.

Solid flanges are formed on the shaft to take the fly-wheel and reverse gear couplings, while at the after end of the shaft there is also the main bevel drive for the two cam shafts and the starting mechanism. The engine bearers may be remarked upon. They are rigid in construction and are formed by continuing the box girder construction of the main bearing webs to the outside of the crank case. At the centre of the crank case casting a passage is formed through which air is supplied to the carburetters. On either side of the crank case there are doors large enough to allow any piston complete with its connecting-rod to be withdrawn.

The cylinder jacket castings are made of annealed cast iron, and as they are secured to the crank case by internal bolts and studs an unbroken line with the crank case and cylinder heads is obtained. Each jacket casting is so designed that the ports may serve either for induction or exhaust and the end passages either for crank case ventilation or carburetter air passages. These castings are interchangeable in the forward and aft positions.

The cylinder liners are made of close-grained cast iron, are symmetrical in shape and are machined all over. They have a flanged joint at the upper end and a jointing belt lower down. They are pressed into their castings and the water joint is made with oil-proof rubber rings, and over the end of each liner there is clipped a light oil splash guard. The pistons are made from a 12 per cent. copper-aluminium alloy, and they have a thick crown which is webbed to conduct away the heat. In the way of the gudgeon pin boss the skirt of the piston is relieved, while grooves and holes for carrying away surplus oil are provided in the lower part. Three compression rings and one scraper ring are fitted, the two upper compression rings being of the hammered concentric type and the two lower of the double "Clupet" pattern. The hollow hardened steel gudgeon pin is a floating fit both in the small end bush and in the piston bosses, and bronze buttons are fitted to it at either end to keep it in position. Splash lubrication is provided for by drilling suitable holes in the piston bosses and the small end, in the upper part of which an oil reservoir is formed. The connecting-rods are drop forgings of H section and the length between the centres is 10½in. The big ends are of the claw type with four bolts, a white-metalled shell bearing being used for the bottom end and a solid bronze bush for the top ends. Both the main bearings and the big end bearings are die cast into bronze shells with the oil grooves cast in the white metal.

Cylinder Heads and Valve Gear.—A feature of the design which has already been touched upon is the provision of a cylinder head which is small and light enough to be lifted for examination by a single attendant. The heads, each of which is for two cylinders, are made of annealed cast iron and they carry the necessary ports for the induction and exhaust as well as communicating passages for crank-case ventilation and carburetter air. On each side of the combustion space is arranged a pocket for the accommodation of the sparking plug. Large cleaning doors are arranged at each end of the cylinder head and also at each side, giving access to the water jacket spaces. Water is conveyed from the cylinder jacket boxes into the head through spigot bushes fitted with rubber rings which make the water joints and isolate the main cylinder joints from contact with the circulating water. To each side of the cylinder head is attached a box which covers the sparking plug pockets of each pair of cylinders and carries the ignition wires from the magnetos. Access to each pair of plugs is obtained by means of a readily detached door. The boxes also form a means of transferring water to the cylinder head from the inlet and exhaust pipes. They are

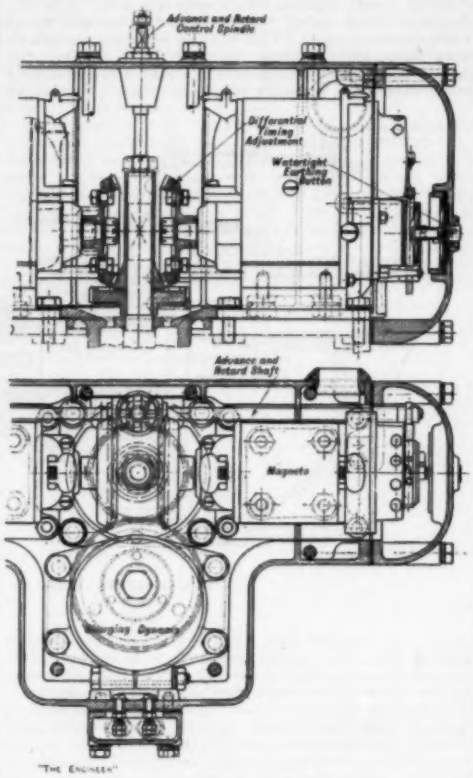


FIG. 1—MAGNETO AND DYNAMO DRIVES

permanently attached to the cylinder head and, apart from constructional difficulties, could have been made part of the same casting.

Light aluminium casings are arranged to cover the whole of the valve mechanism, which is mounted on the top of the cylinder head. These covers are provided with large-diameter pipes for the air feed to the carburetter. In the upper view on page 162 the air feed pipes are not shown; they are, however, seen in the lower views, but are indicated broken to reduce height. The valves are made of suitably heat-treated K.E. 965 steel. They are of the mushroom type, one inlet and one exhaust valve, which are interchangeable, being arranged on the fore-and-aft centre lines of each of the combustion spaces. Each valve is kept on its seating by two helical steel springs, one left hand which is concentrically placed within one right hand; 45 deg. valve seatings are used and the valve cotters are of the split double-cone type wedging on to the valve stem and into the spring holder. The two halves of the cotter are held together by means of a light spring. The valves are lubricated by oil mist from the crank case ventilation air. The valve rockers are made of high-grade steel stampings which are mounted on a central spindle and are carried between two sets of roller bearings. The end of the rocker operating the valve is case hardened while the end operated by the push rod is provided with a spherically ground adjustable push button. For purposes of lightness, case-hardened hollow valve tappets are employed. At the lower end, where they come into direct contact with the cams, flat palms are formed, and at the opposite ends hard steel plugs make contact with the push rods. These tappets work in bronze guides pressed into the crank case and flood lubricated, and each is separately accelerated by an independent spring fixed between the jacket box and cylinder head. The push rods are made from ¼in. diameter silver steel and at the upper end are fitted with spherically ground cups which engage the valve rocker button. These cups are grooved for the retention of grease which is fed through the hollow bore of the rocker gear. Any clearance between the valve end and the rocker or between the push rod and the rocker is taken up by means of a spring interposed between the underside of the head of the push rod and the top space of the cylinder head. The impact of the movement of the valve mechanism is thus taken up on the oiled surface of the tappet head within the crank case and noise is thereby reduced to a minimum.

As will be seen from the drawings, two separate cam shafts are employed for the inlet and exhaust valves. Their respective cams are formed solid with the shaft and the profiles are ground to contour and dimensions. The shafts are made hollow for lubrication and individual oil supplies are taken to all cam shaft gearings and to the cam faces. The driving gears are plain spur wheels attached to a carrying flange which is mounted on splines at the rear end of each shaft, and differential holes are provided in the wheels and flanges to permit adjustment of the timing of the engine.

In order to obtain the necessary unidirectional rotation for the cam shaft and auxiliary drives when reversing the crank shaft rotation, bevel wheels are interposed and arranged in such a way that the drive can be taken from either side of a primary pinion.

Ignition, Starting and Battery Charging Arrangements.—Each head carries two independent sparking plugs and current is provided by two high-tension magnetos situated at the forward end of the engine. Fig. 1 shows the general arrangement of the magneto and charging dynamo casings, the bevel drives, and the advance and retard control shaft. The magnetos are driven by bevel gearing on which arrangements are made for timing adjustment; they are synchronously controlled by means of a single shaft. Detachable covers on either side give access to the contact breakers and the distributors of the two magnetos. These covers are fitted with water-tight rubber diaphragms and with switches for testing and stopping the engine. A detachable cover is also provided at the top of the casing and gives access to the commutator and brush gear of the dynamo.

All the high-tension wires from the magneto to the starting plugs are carried through the wire boxes already referred to. The aluminium casing in which the magnetos and dynamo are housed is ventilated from the crank case, air being drawn in past the connecting wires into the wire boxes and thence across the sparking plugs into the carburetter air intake. By this means cool plugs are maintained. The dynamo is used for battery charging and lighting services. It is fixed at the front of the magneto drive and is driven by spur gearing from the vertical drive shaft. This is the only component which is affected by variation in rotation of the crank shaft, and a correction for this has to be made by the electrical reversing of the field connections. An electric starting motor is arranged at the front of the engine. It operates a Bendix gear, the pinion of which meshes with the fly-wheel gear ring, the motor drive being transmitted through a pair of right-angled spiral gears. The starting motor is totally enclosed and is built into the front end cover of the engine with the battery leads coming out through water-tight glands. Both the Bendix gear and the terminal connections may be arranged either inboard or outboard as may be convenient. An auxiliary hand starting and barring gear is also provided and is fitted directly over the cam shaft driving mechanism at the rear end of the engine. It may be always operated in a right-hand direction irrespective of the direction of rotation of the engine.

For purposes of timing the engine the fly-wheel rim is polished and is marked on the periphery showing the top dead centres of the cranks. An inspection door over the fly-wheel allows these markings to be observed and an indicator is fitted to assist the operation of timing.

Governor and Automatic Throttle Controls.—The governor is a self-contained unit, mounted in ball bearings on the top of the forward end crank shaft bearing and driven by bevel gearing from the back side of the fly-wheel. It is of special design, utilising the centrifugal action of three ¾in. diameter steel bearing balls, which are carried on a circular inclined plane and retained in position in milled guide slots in the cover plate of the governor body. The cover plate is rigidly fixed to the driving pinion, whilst the inclined plane is spring mounted and moves under the influence of the centrifugal action of the balls, transmitting a vertical motion to the control sleeve which operates by means of internal rods and levers the independent governor butterfly valve arranged in the carburetter induction pipe.

In Fig. 2 we show a general arrangement of the automatic throttle control gear which predetermines and sets

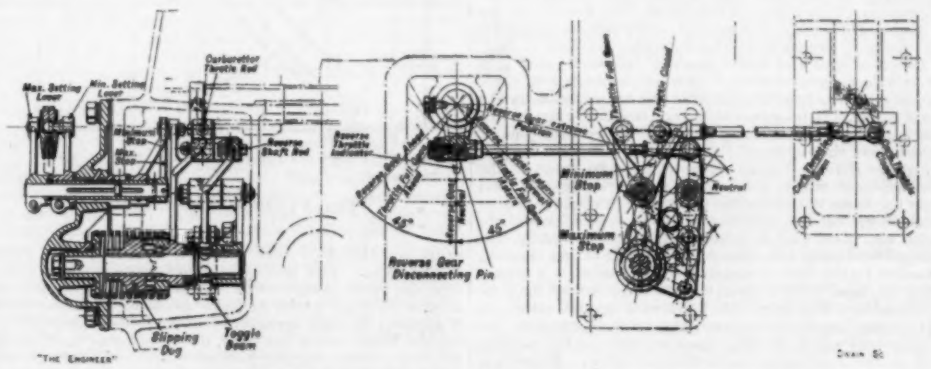


FIG. 2—ARRANGEMENT OF AUTOMATIC THROTTLE CONTROL GEAR

maximum and minimum throttle positions for the engine so that movement of the hand control wheel either in an ahead or an astern direction suffices to control and manœuvre the boat as may be required. As will be seen from the drawing, the control mechanism comprises a series of rods and links whereby a single-way motion is transmitted to the carburetter throttle lever independently of the direction in which the control hand wheel is turned. The necessary over-running movement is obtained by transferring the control lever motion to a horizontal spindle shown to the left hand of Fig. 2, which is furnished with spring-controlled dogs of the slipping ratchet type. The action of moving the wheel to either the ahead or astern position opens up the throttle to the pre-arranged position, and on coming again into neutral position closes it to a predetermined minimum. The arrangement is one which not only prevents any possibility of the engine being stopped, even under the most adverse conditions of operation, but at the same time it has the important function of reducing the human element of control to making one movement only. For the purpose of dismantling the reverse gear a disconnecting pin is provided, which, when taken out, allows the reverse gear to be removed without having to interfere with the link mechanism. The whole of the mechanism shown, complete with its rod and connections, is automatically lubricated and is housed within the crank case. An inspection door is attached which gives access to it.

Auxiliary Pumps.—The water pump, which we do not illustrate, is of the double helical tooth gear type, and is driven by a coupling from the back end of one of the cam shafts. The casing is so arranged that the water inlet and outlet are fixed on a common centre line, and the position of the assembly can thus be changed without affecting the pipe circuit. Fig. 3 shows a section through the lubricating oil pump. This is a triple pump and is also driven through a flexible coupling from the back end of the other cam shaft. The pump is of the plain straight tooth gear type, the first two sections being designed to act as scavenging pumps to the crank case and reduction gear. The oil taken by the pump from these parts of the

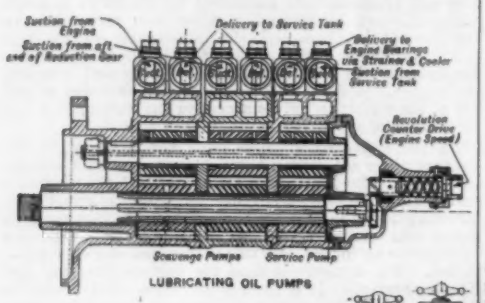


FIG. 3—LUBRICATING AND BILGE PUMPS

engine is delivered to a service tank. The end pump is a service pump for the bearings. Both the outlets and inlets of the three pumps are arranged on a common lateral centre line, so as to permit of transposing them from one engine to another without any variation in the run of piping. In the forced lubrication circuit there are a relief valve set to maintain the working pressure at 15 lb. to 20 lb. per square inch, and an Auto-Klean strainer of large size, with a full way safety valve set at 50 lb. per square inch, which would relieve the pressure on the system and cooler in the event of excessive pressure caused by very viscous oil. A permanently running bilge pump, shown in the lower part of Fig. 3, is arranged athwart the engine at the front end beneath the capstan drive mechanism. This pump and its drive form a unit and can be assembled either inboard or outbroad as required. The pump is driven from the fly-wheel through a shaft by means of spur and spiral gearing. Another pump is of the valveless spring-returned plunger displacement type, the duty of which is to maintain the air pressure on the petrol tanks. It is operated by an excentric cam on the inlet cam shaft and is situated below the exhaust pipe at the centre of the engine.

Capstan Drive.—Special reference may be made to the capstan drive, which is arranged as a separate unit, and forms the lower portion of the front end cover of the engine crank case. It consists essentially of a small metal-to-metal wet plate clutch which is kept permanently disengaged by means of a spring and a small thrust bearing. Attached to the driven member of the clutch is a pinion which engages with a spur wheel. This wheel may be moved about 5in. from the horizontal centre, either to port or starboard, as required, and to it is attached the driving shaft which operates the worm drive of the capstan through the medium of a flexible coupling. Pressure is applied to the clutch plate by an hydraulic ram operating on a ball thrust bearing. The control ram with its cylinder is attached to the end cover immediately ahead of the clutch spindle.

Carburetter and Induction System.—The carburetter is a special Hobson-R.N.L.I. submersible type, having suitable flanges arranged for its attachment to the crank case and induction manifold. Its air supply is taken by way of the air pipes attached to the two cylinder head covers, drawn across the cylinder head and valve mechanism, thence down the centre box web of the crank case, into the air chamber of the carburetter. The float chamber is hermetically sealed, the venting being effected by means of a balance pipe into the air chamber. A strangler valve is fitted beneath the choke tube, and an independent governor throttle is also provided, in addition to the main control throttle. Both the main and slow running jets are centrally displaced in the float chamber, so as to ensure satisfactory performance under all conditions of motion of the boat.

Reverse and Reduction Gears and Controls.—The reverse gear is housed in a robust casing made of sea-water resisting aluminium. At its forward end this casting is flanged and spigoted for attachment to the engine crank casing, while at its after end it is flanged to carry the reverse gear and reduction gear bearing housings. On the top of the casing there are mounted the operating controls for the clutches, and access to internal parts is given by inspection doors. At the base of the housing are four bearers of box section which are machined to be in alignment with those on the engine bed-plate. The reverse gear itself is of the planetary internal spur type, and the wheels are made from heat-treated nickel-chrome steel. There are three planet pinions which take the drive from the sun pinion and transmit the motion to an internal wheel on the reversing shaft. This wheel is attached in turn to the reversing shaft through the outer clutch member, the inner clutch member being directly coupled to the engine shaft through the primary reversing shaft. The ahead

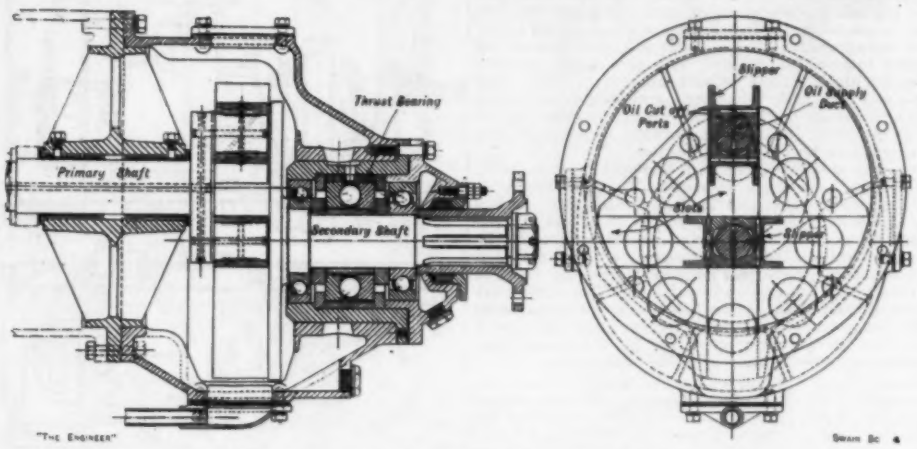


FIG. 4—BURN-R.N.L.I. SPEED REDUCTION GEAR

clutch is so designed that when it is engaged all load is removed from the reverse gear, which is only stressed when the reversing shaft is moving in the astern direction. The ratio of ahead to astern transmission is 5 : 4, and for a given throttle opening a speed increase of 25 per cent. is therefore given when running astern. As will be seen from the upper illustration on page 162, the whole of the reverse gear with its control and housing is arranged as a detachable unit. It is connected to the engine through an oil damped coupling of the internal toothed type.

The ahead clutch is of the plate pattern, there being nine plates, each $^{11}/_{64}$in. in thickness, alternately bronze and steel. They are forced together by four roller type dogs operated by a cone. The plates are anchored both in the driving and driven members by key-shaped projections which engage in slots, and oil shearing grooves are provided to allow the clutch to take up its drive easily and without shock. For the astern motion a pair of locomotive type cast iron brake shoes, which grip the epicyclic

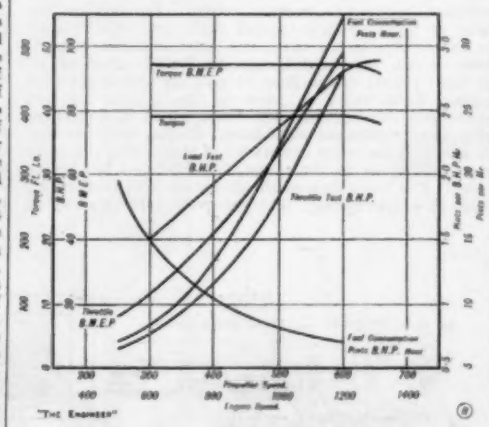


FIG. 5 BENCH TRIAL RESULTS

drum and thereby reverse the motion of the driven shaft, is employed. The pivoting of the shoes is so arranged that the drum is allowed to float in its own bearings, and is relieved from lateral and side pressure when the brake is applied. Special arrangements are provided for adjusting the brake shoes and there is an indicator to show the amount of wear and the position of the two brake blocks. At the top of the reverse-gear casing is the screw shaft which operates the ahead and astern clutches and the automatic throttle gear.

Brief reference may be made to the 2 : 1 speed reduction gear, which is of a special Burn-R.N.L.I. type, and was supplied by Stothert and Pitt, Ltd., of Bath. This gear, which was described in our issue of December 11th, 1925, is in essence a two-toothed pinion, in which the teeth of the primary element take the form of slipper blocks mounted on crank pins, as shown in Fig. 4, the teeth operating in four slots formed in a disc on the secondary shaft. The primary shaft is an extension of the reversing gear shaft, while the secondary shaft is an independent component which is carried in Hoffman type ball bearings. A ball thrust bearing is also provided to take the thrust of the propeller in both directions. Special arrangements are made to lubricate the gear. Oil under pressure flows to a central passage drilled in the reversing gear shaft and is delivered through holes in the disc to the crank pins and slipper faces of the reduction gear. As shown in our illustration, special oil ports are arranged in the crank pins which automatically cut off the supply of oil, while the slipper is passing the central slot. The thrust bearings are flooded with surplus oil.

It may be mentioned that the secondary shaft is so arranged that it is 2¼in. from the centre line of the primary shaft, and this dimension can be fixed in either an upward, downward, inboard or outboard direction, as may be most convenient. The end of the secondary shaft is furnished with a splined-on coupling, the outside diameter of which runs within a packed gland, so that there can be no escape of lubricating oil and no water can enter the bearings. The whole design is such that the complete thrust block can be quickly dismantled for inspection or adjustment.

Trials and Service Performance.—The results which were obtained from actual bench trials of a 40 B.H.P. four-cylinder engine run at the builder's works, are reproduced in Fig. 5. They are plotted on a base of propeller speed, but the engine speed is also given for purpose of reference. As shown, these results include the mechanical loss in the reduction gearing. If we take into account the purpose for which the engine was designed, namely, that of extreme reliability, the performance may be said to be an eminently satisfactory one. A feature of the curves to which we may draw attention is the flat character of the torque lines, indicating that it is possible to run the engine advantageously over a wide variety of propellers.

With regard to performance under actual service conditions, it may be mentioned that, prior to any sea trials being run, the first engine underwent a "type" test of 100 hours' duration, during which time it was run continuously under full throttle conditions. That trial having been successfully carried out, the engine, together with a sister unit, was installed in a lifeboat, and, as described in THE ENGINEER of April 8th, 1927, full-power sea trials were run in the Solent with the engines completely submerged. In addition to the artificially created conditions of submergence, the weather in the Solent was very rough all the time the tests were made, but the engine ran extremely well, and responded easily to the controls. Since the trials of the first engine were made, two further four-cylinder units have been put into commission, and are used to drive a single screw by means of appropriate coupling mechanism. The object of building this special installation was to obtain comparative data on single screw and twin screws in boats of similar form. The two lifeboats in which the single and twin engines are placed are stationed at Rosslare in Ireland and Piel Island, near Barrow-in-Furness.

A further interesting installation which is now approaching completion, and in which two six-cylinder units will be employed is the new lifeboat for Stromness, Orkney. She will be sent to her station on February 16th. To date, eight four-cylinder units of the type we have described have been tested, and the two six-cylinder units already referred to, in addition to which there are a further twenty engines under construction.

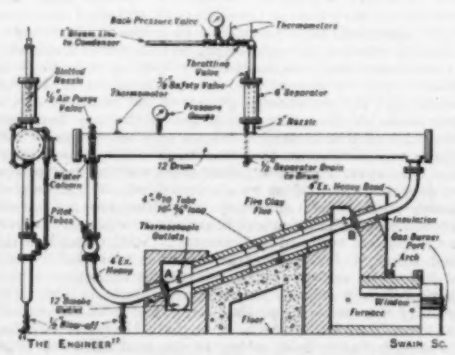
We would congratulate the Royal National Lifeboat Institution and the builders of the engine, mentioning in particular Captain H. F. J. Rowley, R.N., Chief Inspector of Lifeboats; Engineer-Captain A. G. Bremner, R.N. (Ret.); and Mr. A. C. Butcher, M.I.A.E., the latter being chiefly responsible for the engine design; on their production of a new type of engine which has fulfilled its duties and advances still further the scope of lifeboat service.

WORK has begun on a new potable water supply system for the town and suburbs of Cordoba, estimated for an eventual population of 150,000. Cordoba, one of the most important towns of Argentina and the centre of a rich agricultural and cattle country, stands 1440ft. above sea level on the right bank of the Rio Primero at 432 miles from Buenos Aires. The contract calls for two tunnels through the hills, one 1¾ miles and the other five-eighths of a mile long; several dams at Calera at 7½ miles from the town; and a modern filtering and sterilising plant at Alta Alberdi. Covered conduits will be used for conveying the water to and from the filtering plant. The estimated cost of the undertaking is between 5,750,000 and 6,000,000 pesos (paper).

Heat Transmission through Boiler Tubes.

A PAPER of very considerable interest to steam engineers, written by Mr. Huber O. Croft, assistant professor of mechanical engineering, has recently been published by the University of Illinois. It deals with the rate of transmission of heat through a boiler tube from the outside inwards; that is to say, a water-tube boiler—not after the fashion of a fire-tube boiler, as has generally been the case in such investigations. The information given is also noteworthy through the meticulous care used by the experimenter to take into account all those variations from full-sized practice in boiler construction which were necessary in an experimental installation. Thus, for instance, it was obvious that, working with only one water tube, that tube would not be subject to the cooling effect of the adjacent tubes of a full-sized boiler, but would be effective throughout its circumference. Mr. Croft, however, endeavours to analyse the various means by which the tube received its heat, so as to minimise such matters. It would be impossible here to give more than a *résumé* of a paper covering some sixty pages of print, so we content ourselves with reproducing a drawing of the experimental plant and reprinting some of the passages of the paper *en bloc*.

The experimental boiler drum was of 12in. standard pipe slightly over 17ft. long. The headers were of 4in. standard pipe and the bends were of 4in. extra heavy pipe. The 4in. No. 10 B.W.G. boiler tube constituting the heating surface was 10ft. 3in. long, giving a gas side heating surface of 10·55 square feet. The slope of the tube was 21 deg. to the horizontal. Steam leaving the top of the drum entered a steam separator draining to the bottom of the drum. From the separator the steam passed through the pressure control valves into the condenser. All parts of the boiler, with the exception of the test tube and flanges, part of the water column, and those flange joints which might have to be broken, were insulated with 85 per cent. magnesia. The steam separator and lead were likewise



THE EXPERIMENTAL PLANT

insulated for 18in. beyond the back-pressure valve. The remainder of the condenser steam lead was left bare intentionally to assist the condenser in its function.

The gas-fired furnace, with arched top and stays, was constructed of fire-brick. It was 18in. wide, 20in. high, and 36in. long. The 18in. square uptake and the smoke connection chamber were also made of fire-brick. The fire-clay gas flue surrounding the water tube had an internal diameter of 12in., giving an effective gas passage area of 0·716 square foot after subtracting the cross-sectional area of the water tube. The flue gases were discharged from the setting by a 12in. diameter smoke connection at the bottom of a 40in. by 40ft. chimney.

The water velocity in the "downcomer" header of the apparatus was determined by two Pitot tubes connected to a Venturi meter manometer. The room, Pitot tube manometer, gauge board, primary and secondary air, gas, drum steam, and throttling valve temperatures were taken with mercury thermometers calibrated by comparison with a certified Bureau of Standards thermometer. The steam temperature thermometers were calibrated in contact with a Bureau of Standards thermometer in oil, and stem connections were applied in all cases.

Chromel-alumel thermo-coupled wire of one of three sizes, namely, No. 22, 14, or 11 B. and S. wire, was used, depending upon the purpose. All couple ends were twisted and acetylene welded to a ball tip with borax as a flux.

The couples used to determine the temperature of the water in the tube were formed to give a 2in. extension upstream in order to neutralise the heat conduction from the flue gas and tube wall to the couple junction. Twelve coats of insulating enamel were baked on after the couple leads had been insulated from each other by small glass beads. The insulated couples were then tested with a sensitive galvanometer and dry cells for electrical leakage in boiling water, but no leakage was evident.

Each series of tests usually consisted of four separate tests. For each series the gas flow and temperature were maintained constant, and for each successive test of any series the steam pressure was increased between tests. The steam pressure steps were usually 10 lb., 50 lb., 100 lb., and 140 lb. per square inch gauge. The procedure was as follows:—The apparatus was filled with water and the water column level and water temperature noted. The total weight of water in the apparatus was then known from the water volume calibration of the apparatus before the test was begun. The gas burner was lit and the gas and air flow adjusted to give the gas temperature and rate of flow desired. The apparatus and water were heated with the discharge valve closed until the desired test steam pressure was obtained. This warming-up period required from an hour to three hours, depending on the rate of gas flow and the gas temperature. When a positive drum pressure was reached the drum was purged of all air. When the first test steam pressure—usually 5 lb. gauge—was reached the back-pressure valve was opened wide and the throttling valve was opened and adjusted so that the steam pressure remained constant; the amount of steam discharged during this adjusting period was condensed and weighed. When constant steam pressure was obtained and the apparatus had attained temperature equilibrium the test was started and the steam generated during the test period was condensed and weighed. This test period was usually an hour. When the test period was completed the throttling valve was closed and the steam pressure allowed to increase to the next test pressure, usually 50 lb. gauge. The throttling valve was then adjusted to give constant steam pressure and the steam generated under constant conditions for the test period was again condensed and weighed. The remaining tests—usually at 100 lb. and 140 lb. gauge—were conducted in a similar manner. The condensed steam discharged between tests during the pressure adjusting period was always weighed and recorded in order that the weight of water in the apparatus at the beginning and the end of the test could be calculated. This was necessary to determine the amount of heat added to the water in the apparatus if the steaming pressure was increased, since this heat did not appear in the steam condensed. In other words, this was necessary to determine the net change in the heat of the liquid of the water in the apparatus if the pressures (and saturation temperatures) at the beginning and end of the test were not the same.

All of the heat energy received by the test tube was not transmitted directly by convection and radiation from the flue gases, as the fire-clay flue was at a higher temperature than the test tube, and therefore radiant energy was transferred from the inner surface of the flue to the tube.

The total heat received by the tube can be separated into two parts: (*a*) that received by flue gas convection and radiation; and (*b*) that received by radiation from the inner surface of the flue.

The total heat energy absorbed by the tube can then be expressed as follows:—

$$H_t = H_c + H_r \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where

H_t = total heat energy received by tube in B.Th.U. per hour.
H_c = heat energy received by convection and radiation from the moving gas stream in B.Th.U. per hour.
H_r = radiant heat energy received by tube from flue in B.Th.U. per hour.

H_r can be calculated fairly accurately from a form of the Stefan and Boltzmann law if the radiation coefficients and temperatures of the radiating and absorbing bodies are known. If the radiating surface completely encloses the absorbing body, and if the radiation is so-called "black-body" radiation, this law can be expressed by the equation

$$Q = S\frac{e_1 e_2}{E}\left[\left(\frac{T_1}{1000}\right)^4 - \left(\frac{T_2}{1000}\right)^4\right] \quad . \quad (2)$$

where

Q = heat radiated in B.Th.U. per hour.
S = absorbing surface in square feet.
e_1 = emissivity coefficient of enclosure.
e_2 = emissivity coefficient of absorbing body.
E = emissivity coefficient of black body.
T_1 = absolute temperature deg. Fah. of enclosure.
T_2 = absolute temperature deg. Fah. of absorbing body.

This expression is well adapted for the calculation of H_r for this particular apparatus as the radiating surface practically encloses the absorbing body; assuming that "black-body" radiation does exist—which is probably near the truth—the only questionable factors, then, are the emissivity coefficients and the body temperatures.

The emissivity coefficients were taken from the twenty-fourth edition of Hütte's "Ingenieur's Taschenbuch" and were as follows:—

e_1 = 1510 (wrought iron).
e_2 = 1540 (brickwork).
E = 1650 (black body).

The tube absorbing surface (as side) was 10·55 square feet. Equation (7) then becomes

$$H_r = 14\,870\left[\left(\frac{T_1}{1000}\right)^4 - \left(\frac{T_2}{1000}\right)^4\right] \quad . \quad . \quad . \quad (3)$$

The method used to determine the value within the brackets in this equation for each test was largely graphical.

Two sets of heat transmission coefficients have been calculated, namely, a "total" coefficient calculated from H_t and indicated as K_t in the table, and a "convection" coefficient calculated from H_c and indicated as K_c in the table.

K_t was calculated from the expression

$$K_t = \frac{H_t}{S \times \Delta T} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where

K_t = total coefficient of heat transmission in B.Th.U. per square foot per deg. per hour.
H_t = total heat energy received by test tube in B.Th.U. per hour.
S = gas side surface of test tube in square feet (10·55 square feet).
ΔT = logarithmic mean temperature difference between flue gas and water in the test tube in deg. Fah.

K_c was calculated from equation (9) by substituting H_c (convection heat energy received by tube in B.Th.U. per hour, for H_t.

ΔT was calculated from the expression

$$\Delta T = \frac{\Delta t_1 - \Delta t_2}{\log_e \frac{\Delta t_1}{\Delta t_2}} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where

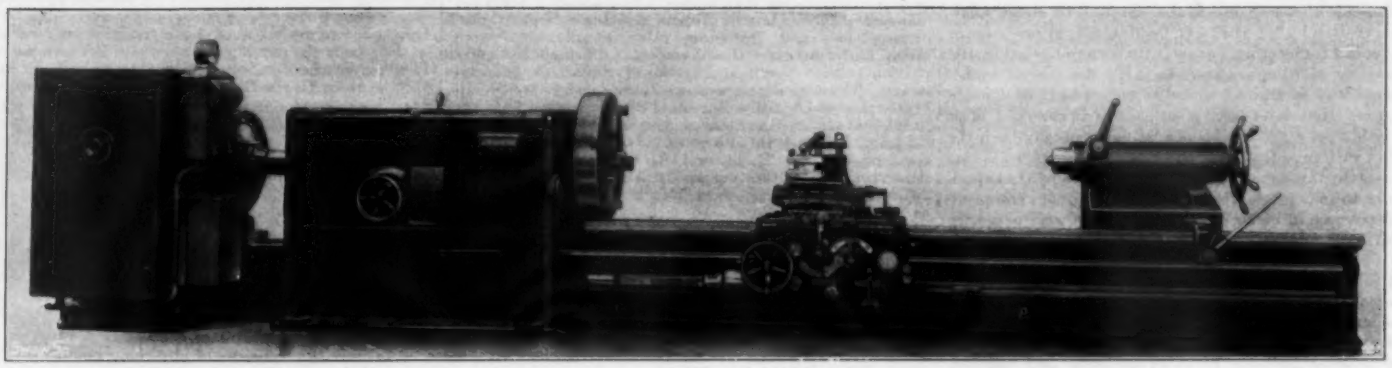
Δt_1 = arithmetical temperature difference in deg. Fah. between flue gas and water at furnace end of tube (10 W − 2 W).
Δt_2 = same as above at smoke outlet end of tube (18 W − 7 W).

Heat Transmission Through Boiler Tubes, Calculations and Results.

Abs. steam pressure, lb. per sq. in.	Av. $\left[\left(\frac{T_1}{1000}\right)^4 - \left(\frac{T_2}{1000}\right)^4\right]$	Heat by radiation B.Th.U. per hour. H_r	Heat by convection B.Th.U. per hour. H_c	Average flue gas temperature deg. F.	Log. mean temp. diff. T.	Total coef. of heat trans., B.Th.U. sq. ft. deg. hr. K_t	Convection coef. of heat trans., B.Th.U. sq. ft. deg. hr. K_c	Lb. flue gas per minute.	Flue gas properties.								Total cu. ft. gas per min.	Gas vel., ft. per sec.	Water velocity, ft. per sec.
									Lb. water vapour per min.	% by vol. CO_2.	% by vol. O_2.	% by wt. CO_2.	% by wt. O_2.	% by wt. N_2.	% by wt. H_2O.	Specific volume, cu. ft. per lb.			
(5)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
28·5	1·639	24 240	38 730	1109	859	6·950	4·274	6·46	0·489	6·4	9·9	9·0	10·0	74·0	7·6	42·15	272	6·34	1·09
64·9	1·676	24 910	35 910	1152	854	6·756	3·988	6·43	0·507							43·30	278	6·48	1·44
64·6	2·154	32 060	28 600	1180	881	6·522	3·074	6·73	0·477	7·8	10·0	10·72	10·0	72·5	7·26	43·40	293	6·81	1·05
144·4	2·246	33 400	41 640	1219	863	8·240	4·575	6·81	0·502							44·45	306	7·11	1·12
23·3	1·483	22 050	23 360	1043	802	5·370	2·760	9·89	0·538	4·5	14·3	6·42	14·8	73·6	5·5	40·12	397	9·23	0·58
63·2	1·626	24 190	34 370	1068	770	7·205	4·230	9·71	0·539							38·12	370	8·61	1·08
116·3	1·600	23 800	32 870	1084	744	7·220	4·187	9·67	0·527	3·9	15·1	5·57	15·65	73·5	5·71	41·81	404	9·41	1·41
155·4	1·646	24 490	33 080	1097	735	7·419	4·260	9·54	0·567							42·04	401	9·33	1·33
31·5	1·093	16 250	31 190	982	724	6·210	4·080	16·52	0·554	2·8	16·9	4·09	17·95	74·8	3·34	37·90	626	14·6	0·868
57·8	1·083	16 110	33 980	997	702	6·761	4·585	16·97	0·567							38·29	650	15·1	1·09
120·0	1·062	15 800	32 070	995	651	6·960	4·665	16·84	0·616	2·6	16·9	3·79	17·95	74·8	3·67	38·39	647	15·1	1·34
159·0	1·058	15 740	31 400	996	632	7·070	4·710	16·75	0·618							38·41	644	15·0	1·54
21·7	0·991	14 740	29 092	899	645	6·440	4·272	21·70	0·805	2·4	16·9	3·53	18·10	74·9	3·66	35·48	770	17·9	1·23
62·9	0·931	13 850	28 393	900	601	6·660	4·475	21·66	0·802							35·50	770	17·9	1·39
114·5	0·867	12 900	26 996	896	555	6·810	4·610	21·71	0·779							35·41	770	17·9	1·83
158·11	0·828	12 310	22 197	902	537	6·090	3·914	21·47	0·777							35·57	764	17·8	1·98
20·5	1·501	22 320	30 514	1039	804	6·235	3·600	13·44	0·577	2·3	19·3	3·19	20·78	72·45	4·21	39·16	527	12·3	1·48
74·9	1·426	21 200	31 475	1092	781	6·395	3·820	13·52	0·566							40·55	549	12·8	1·70
118·7	1·295	19 210	32 015	1065	710	6·842	4·275	13·75	0·582							39·85	548	12·8	1·75
159·2	1·212	18 030	33 944	1054	695	7·081	4·630	13·61	0·557							39·82	544	12·7	1·68

EXTRA HIGH-SPEED LATHE

THE SCHIESS-DEFRIES MACHINE TOOL CO., DUSSELDORF, ENGINEERS



The following empirical formulas were determined from the results :—

$$K_c = (0{\cdot}000977\ \Delta T + 0{\cdot}0025\ T_w + 0{\cdot}0855\ W_a + 0{\cdot}00294\ T_g - 1{\cdot}83) \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$K_c = (0{\cdot}000715\ \Delta T + 0{\cdot}00153\ T_w + 0{\cdot}0927\ V_s + 0{\cdot}00282\ T_g - 0{\cdot}9) \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where

K_c = "convection coefficient" of heat transmission in B.Th.U. per square foot per deg. Fah. per hour.
ΔT = log. mean temperature difference between flue gas and water in tube.
T_w = temperature of water in tube in deg. Fah.
W_a = rate of gas flow (W ÷ A) in lb. per min. per square foot of gas passage area.
V_s = velocity of gas in feet per sec.
T_g = average temperature of gas in deg. Fah.

Equation (6) has the greater accuracy because of the greater consistency of the coefficient relations with respect to rate of gas flow in pounds per square foot per minute than with respect to the gas velocity in feet per second. No attempt was made to express K_c relations in the form of an equation because of the complications introduced by radiation from the flue.

Relations Between Coefficient of Heat Transmission and Water Velocity.—It was difficult to determine the effect of the water velocity on the coefficients of heat transmission because of the fact that for each test of a series the steam pressure was changed with a resulting change in water velocity and coefficients. To separate the effects of changes in steam pressure and water velocity, the tests were plotted on logarithmic paper separately for each test pressure with K_c water velocity, and temperature difference between tube and water as co-ordinates. The relations of the velocities with the variables just given were irregular, but when broadly interpreted seemed to follow the expression

$$K_c = A\ V_w^{0{\cdot}128} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where

A = a constant for any one steam pressure.
V_w = water velocity in tube in feet per minute.

Thus doubling the water velocity increases the coefficient K_c only about 9·5 per cent.

CONCLUSIONS.

As a result of this investigation the following conclusions may be drawn :—(1) The coefficient of heat transmission of the apparatus is affected by (*a*) the rate of gas flow ; (*b*) the temperature difference between flue gas and water ; (*c*) the pressure at which steam is generated ; (*d*) the temperature of the gas stream. The coefficients may be expressed in terms of the variables by means of equations (6) and (7). (2) The water velocity in the tube has slight effect on the overall coefficient of heat transmission as expressed broadly by equation (8). (3) The water velocity in the inclined tube of the apparatus varies as the steam rate and total energy input, and tends to approach a practical maximum at slightly over 3ft. per second. (4) The water velocity is affected by the steam pressure. (5) The temperature gradient from the flue gas to the water in the tube varies with the flue gas temperature, the rate of gas flow, and the steam pressure.

A New Lathe and a New Tool.

THE Raw Material Exhibition, which opened in Berlin on October 22nd, established, we believe, a precedent in exhibitions in so far that the exhibitors were not allowed to disclose their identities. Among the exhibits was a new tool material of remarkable properties. From certain information in our possession we are led to the belief that this material is "Widia" metal, and that it is made by Fried. Krupp at Essen. We do not know its composition and have no evidence that would justify our describing it as a steel. It is supplied in the form of tip pieces which are brazed on to shanks of suitable form either with brass or copper as the brazing material. So far as we can gather, the material is supplied in the form of small castings, which, except for the brazing process and subsequent grinding, are ready for use. During the brazing the metal may reach a temperature of from 700 deg. Cent. to 1150 deg. Cent., but it would appear that if it is slowly cooled down subsequently in contact with pulverised electrode carbon its cutting properties are not affected. For grinding purposes a special kind of carborundum wheel is stated to be essential. The material, we gather, cannot be forged, and can only be brought to shape by casting and grinding. In the prepared form it is said to have a hardness only slightly inferior to that of diamond.

The prime feature claimed for the metal is not that it enables heavier cuts to be taken, that is to say, cuts of increased cross-sectional area of chip, but that it enables the usual cuts to be taken at a greatly increased speed. So great is the increased speed which the metal permits that—so it is reported to us—no existing lathe could be found that would stand up to the work. It is not in our power to confirm or deny this report. We can, however, record the fact that to demonstrate the quality of the new metal at the Berlin Exhibition, an order was placed with the Schiess-Defries Machine Tool Company, of Düsseldorf, for the special high speed lathe illustrated above and on page 158. It is stated that this lathe is the only machine in existence on which the new cutting metal can be used to its full capacity.

The lathe has 16in. centres and can accommodate lengths up to 10ft. It is driven by a 35 horse-power continuous current motor mounted on an extension of the bed beyond the headstock. This motor, together with change-speed gearing in the headstock, enables the main spindle to be run at speeds up to 600 revolutions per minute. The machine is designed to sustain cutting speeds as high as 450ft. per minute—corresponding to work 3in. in diameter rotating at 600 revolutions per minute. On work 2¼in. in diameter a cutting speed of 330ft. per minute has been achieved—corresponding to a rotary speed of 560 revolutions per minute.

The feeds are obtained from a spline shaft extending from the headstock along the full length of the front of the bed. Change gearing on the saddle gives six rates of feed, ranging from 0·1575in. to 0·012in. per revolution of the work, that is to say, the feed can be varied from 6 to 85 cuts per inch. Quick power traverse is communicated to the saddle by means of a 3 horse-power motor attached to the apron. This motor is capable of moving the saddle at a speed of 40ft. per minute, or, put otherwise, of traversing the saddle the full length of the bed in about 15 seconds.

Because of the high speeds and in order to reduce friction to the lowest amount all the spindles, including the main spindle, are mounted in ball bearings. The high rotary speed was held to render undesirable the usual fixed back centre. This centre was consequently arranged to rotate and is mounted in ball bearings.

The bed has wide flat shear surfaces. The saddle carries two tool slides, of which the front one is a compound slide. The entire control of the machine is exercised from the saddle, for at the high speeds employed safety, it is held, demands that the operator should not leave his post even to the extent of going to the headstock while the machine is at work. On the right-hand side of the apron triple push-button control is provided for the regulation of the main driving motor, the controls giving fast forward motion, slow backward motion, and stop. The saddle traversing motor, which may be used to move the saddle whether the main spindle is running or stopped, is controlled by two push-buttons on the left of the apron. The triple push-button control for the main motor is duplicated on the headstock. The high speeds at which the work can be set to revolve cannot be satisfactorily gauged by the operator without instrumental aid. Accordingly a tachometer is built into the apron. In addition, an ammeter is fixed in the headstock in a position making it clearly visible to the operator. By its means he is enabled to regulate his feeds and speeds up to the utmost capacity of the machine.

The end of the bed is designed in such a way that in the future an additional length can be added.

The machine is to be regarded as being specially designed to give economical results on long cylindrical work having small machining allowances. It is not designed as a general purpose machine nor to take cuts of heavy cross-section. It does not, in fact, show to full advantage on heavy forgings with large machining allowances. In Germany current practice is in the direction of employing forging machines which will leave as little as possible for the machine tool to remove, and in general of reducing machining allowances to the lowest possible amount. For that reason, it is claimed, the performance of the lathe illustrated cannot justly be deduced from the amount of metal removed per hour. There are other machines which can surpass it in this respect, but such machines, it is argued, are designed to suit the entirely different manufacturing policy of bringing the metal to shape in the machine tool rather than in the preliminary forging process. They are adapted to deal with heavy machining allowances at low speeds, and could not be profitably employed on work involving the taking of light cuts at very high speeds.

Figures for the performance of the lathe illustrated have been supplied to us, but they must, it is argued, be read in the light of the above remarks. On mild steel having a tensile strength of 38-41 tons per square inch the weight of metal removed was 550 lb. per hour, the depth of cut being 0·3150in. and the feed being 0·0787in. per revolution of the work. The cross-sectional area of the cut was 0·0248 square inch. The horse-power absorbed was 35. On steel of 50 tons to 63 tons strength the same performance, we are informed, was registered.

These figures may perhaps be compared with some representing the performance of "Stellite" cutting tools. Stellite is a cobalt-chromium-tungsten alloy with a small percentage of silicon and iron. From some tests carried out with the material during the war at the National Physical Laboratory, we learn that on a mild steel bar with a depth of cut of 0·125in. and a feed of 0·008in.—*i.e.*, 128 cuts to the inch—the maximum cutting speed which could be employed without deterioration of the Stellite tool was 185ft. per minute. This result was stated to be appreciably better than that obtained under precisely the same condition from two varieties of high-speed steel. Some heavy cutting tests made at the works of C. A. Parsons and Co., Ltd., at about the same time (1918), showed that Stellite on a 30-35 ton mild steel was capable of removing metal at the rate of 450 lb. per hour.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Staffordshire Iron and Steel.

IRON and steelmasters in the Midlands have this week given much sober reflection and serious thought to the remarks of Sir William Larke (Director of the National Federation of Iron and Steel Manufacturers) made at the annual dinner of the Staffordshire Iron and Steel Institute on Saturday last. He pointed out that in the South Staffordshire area manufacturers of iron and steel—not merely wrought iron and pig iron—were producing 40 per cent. of the total quantity made in the country. He intimated, however, that those interested in the wrought iron industry were far too modest. They knew how to make it, but he suggested they did not know how to sell it. They did not make enough song about the difference in quality between their manufactures and those of Belgium. Did they go to the purchasers of wrought iron and point out the great variety of uses to which the metal could be applied, and also demonstrate to them why it was, in numerous instances, superior to steel? At the present they were not doing so either effectively or efficiently. He called their attention to the fact that in 1925 Belgium, which was this country's principal competitor, produced 13,500 tons of puddled iron, 100,000 tons of finished iron, and exported 1,000,000 tons of iron bars. Did the South Staffordshire manufacturers pretend that they could compete with a production of that kind, he asked. They in South Staffordshire must push their goods. It was not sufficient for manufacturers to take their materials to the merchants ; they must go to the consumers and demonstrate the superiority of their products as compared with those of the foreigner. Speaking of the absolute necessity of co-operation to secure industrial revival, Sir William said they were apt to think that so far as the iron and steel industries were concerned, they could live in water-tight compartments in relation to engineering, but that was a mistake. As producers and consumers they had to co-operate to bring about an increase in the employment of British labour and the purchasing power of the country, and if they could do that they would get in the iron and steel industries such an increased volume of production as would enable manufacturers to bring their prices down lower than they were. He was confident there were no real reasons for depression, and that by closer co-operation among all classes and greater efficiency in production we should overcome all difficulties and bring about a definite revival in the general trade of the country. With regard to the steel industry, Sir William held that it must boldly face its difficulties and co-operate for greater efficiency in production if they were to secure increased prosperity. The industry was suffering to-day some degree of depression, but it could be overcome he thought. He remarked that the steel industry had, owing to the coal strike of 1926, somewhat of a spurt in 1927, when we produced 9,000,000 tons, imported 4,400,000 tons, and exported 4,200,000 tons. We thus imported 200,000 tons more than we exported for the first time in the history of the country. The total productive capacity of the country was 13,000,000 tons effective and 14½ millions tons theoretical. Why were they in this difficulty? They were being told that they were inefficient. They all knew as technical men that they would like to be more efficient, and were going on trying to be more efficient, but that was a very different thing to being inefficient. Unfortunately, we had a great genius for self-depreciation. That was bad for our competition abroad, and was not good

for us at home. We had to face the great problem of unemployment and depression in the coal, iron and steel industries. The difficulties arising from these conditions could only be overcome by co-operation, which was absolutely essential if we were to secure industrial revival.

South Staffordshire's Difficulties.

Some of the difficulties of South Staffordshire manufacturers were pointed out on the same occasion by Mr. Owen F. Grazebrook, who said that the district, with its seams of coal 30ft. thick and valuable ironstone mines, had been greatly favoured by Nature. Its geological advantages, however, were being neutralised by its geographical position, which had created a difficulty more serious than that due to the exhaustion of its coal and ironstone mines. The manufacturers of the district had secured for their products a proud, independent position for quality, but they could not now afford to live upon this reputation, even though it was world-wide. Apart from their geographical disadvantages, their troubles were national, and they must cease to think of themselves as the district of South Staffordshire, but as part of Great Britain. That meant that they must sink their sturdy individualism, which had made the district what it was. Referring to the criticism of certain bankers that most of the industries of the country had been depending upon their reputations, and for the last fifty years had not altered their plants, he pointed out that unless an industry made profits it could not rebuild its works, and could not keep abreast of the scientific development that was necessary to maintain its existence. He suggested that the assistance rendered by the banks for that purpose had not been so generous as it might have been. The Mayor of Dudley (Councillor F. J. Ballard) contended that with regard to efficiency the country owed much to the work of the members of the Staffordshire Iron and Steel Institute, and looked to its members to initiate further developments in that direction. He also was of the opinion that the South Staffordshire district could not always live on its reputation. They had to realise that industrially they had got to put their backs to the wall, and that unless they kept abreast of scientific developments and brought their works up to date they would, as manufacturers, sink into the background. He believed that the country had reached the turning point that would lead to prosperity, and that industrially it would be more successful than ever it had been.

Market Conditions.

There is little change in the iron and steel market conditions in the Midlands and Staffordshire, though there are signs of rather more activity in manufacturing circles. The brighter view of trade prospects seems to be spreading, and increased confidence is reflected in the breakdown of that complete insistence on the hand-to-mouth policy of buying which has for so long been evident. Here and there can now be found an inclination to give out contracts for some little time ahead. It is an encouraging sign, and if it gains ground will do something towards priming up the basic industries of the district. The further stiffening of continental steel prices has resulted in slightly more business coming to the Midland mills, but the volume so far is not large.

Pig Iron.

One of the most noticeable features of the Midland market is the continued firmness of pig iron prices. The weakness which was apparent for so long a time appears to have been overcome, and smelters adhere steadfastly to their quotations. Consumers are beginning to pay more attention to the situation, and it is reported that not a few have entered into forward contracts under the impression that values are more likely to advance than to decline. Owing to the comparatively small production stocks are being reduced. On 'Change in Birmingham to-day—Thursday—Northamptonshire No. 3 foundry was quoted £3 and Derbyshire £3 4s. to £3 5s. There was little inquiry for forge grades, quotations for which are regarded as merely a basis for negotiation. Pig iron consumption in this area is not at the moment large, and in the Black Country there are only five furnaces in operation, two of which are turning out cold blast iron. Furnace coke is obtainable at from 12s. to 12s. 6d. per ton at ovens, though some ovenmen are endeavouring to get 13s.

Steel.

Some of the district steelworks continue in steady occupation, catering chiefly for the tube mills. The plate mills have found a better demand for boiler plates in connection with a certain amount of renovation of boilers, the makers of which are just now busy, but constructional engineering demands continue quiet. Local mills have not shared in the improvement to the extent of those districts more directly affected by shipbuilding. Orders are coming in fairly regularly, but they are still for small tonnages, and for delivery at short notice. Birmingham importing merchants are doing much less business in foreign semi-finished steel, mainly because prices of this material have so markedly increased that foreign steel has nearly lost its attraction for re-rollers. Belgian billets obtainable a few weeks ago at £5 7s. 6d. are now quoted at £5 12s. 6d., and even at this price the foreign mills are not keen for business. Blooms are about £5 3s. 6d. Imported finished steel is likewise moving upwards. Steel bars are about £6 7s. 6d. Native makers have not altered their quotations, and the disparity between home and foreign prices is gradually lessening. It has not so far been redressed sufficiently to divert any great volume of business to home mills, except perhaps in the tube strip branch. In this department it is considered that any fresh movement in demand would add very materially to the proportion of business coming to home producers, as the lengthy period required by foreigners for delivery would—present prices considered—put them out of the market with many local consumers of tube strip. Though the quantity of foreign material coming into the Midlands is still large, it is not of such bulk as recently, and is for the most part against orders placed weeks or months ago. Few new contracts are going to continental firms.

Finished Iron.

Staffordshire makers of wrought iron are fairly busy, the activity being most manifest in marked bars required for shipbuilding and engineering purposes. Common bars are, however, being bought on a slightly larger scale. Outside mills which have been endeavouring to attract business by specially low prices are modifying their tactics. Quotations have hardened by about 2s. 6d. per ton, most sellers now asking £9 5s. per ton. Even this figure, however, is fully 20s. per ton below that acceptable to Staffordshire ironmasters. Common bars are in no better request, though the Black Country nut and bolt trade is much better employed than it was. Tube makers are taking moderate tonnages of strip at £11 10s. per ton.

Galvanised Sheets.

Better inquiries for galvanised sheets are being received from the Far East and several of the Dominions and Colonies, as well as South and Central America. India, which has been lagging, is now coming forward with better orders. Locals mills are fairly employed, but the larger mills have insufficient business to keep them in full operation. Values of 24-gauge corrugated sheets continue to range from £13 to £13 2s. 6d.

Scrap.

Fair sales of scrap have this week been made to South Wales at from £2 18s. 6d. to £3 per ton delivered. Some of the steelworks, as a result of the improvement in the tin-plate trade, bringing more mills into operation, have been in the market for larger quantities of melting material than for some time past. Many Birmingham merchants have had no difficulty in securing the top figure.

Ironworkers' Wages.

The decline in selling prices of iron and steel in the Midlands during the last two months of the past year averaged well over 6s. As a result ironworkers' wages, which are regulated by a sliding scale under the Midland Iron and Steel Wages Board, were reduced 2½ per cent. on Monday last, bringing the new rate down to 32½ per cent. above the puddling basis of 13s. 6d. This award operates until April 7th, when the position will again be reviewed. This is the sixth successive fall in the percentage rate, and clearly reflects the decline in iron and steel values over the past twelve months. It is regrettable also to have to record that in November and December the output of the selected firms under the Board was smaller than in any other two months last year. It was only half that recorded in January and February, when, however, the works were busy with orders that had accumulated during the coal stoppage.

Railway Requirements.

Of the orders given out so far this year by home and foreign railway companies Midland firms have secured a fair share, and hopes are expressed that the volume of work already secured will be materially added to in the near future. It became known in Birmingham this week that the Midland Railway Carriage and Wagon Company, Ltd., of Birmingham, is to share with a Sheffield firm an order for 700 sets of wagon ironwork required by the London and North-Eastern Railway Company, for the construction of new wagons of various types during the year.

Midland Coal Scheme.

It is now announced that the scheme for regulating output in the Yorkshire, Derbyshire and Nottinghamshire coalfields has received final approval, and arrangements for giving effect to it are progressing. There is no further statement made regarding the territory to which it will apply.

Miners' Wages.

In the South Staffordshire and East Worcestershire coalfield, as in the Cannock Chase area reported last week, miners' wages are again this month on the minimum scale. The ability of the industry to pay is only 24·76 per cent. on the basis rates, but the men, under the agreement, will receive during February, March and April 40 per cent. The accumulated deficit in this area now stands at £23,469.

Unemployment.

The unemployment returns in the Midlands continue to move in the right direction, each week seeing a further few hundred workers taken on at local manufacturing and engineering works. The latest available statistics show 1474 fewer unemployed than a week ago, the total for the area having now been reduced to 139,367. In the Birmingham district the figures have fallen during the week by 447.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

More About British Tenders.

DIFFERENCES between British and foreign tenders for electrical plant have again been brought before the public by the acceptance by the Stockport Corporation of a Swiss tender of £34,307 for the installation of a 21,000-kW turbine set. This price compares with £52,220 and £60,815, which were the lowest and highest tenders received from British firms. In the course of a letter to the Corporation, the British Electrical and Allied Manufacturers' Association stated that British firms would be prepared to make any reasonable sacrifice to retain in this country the order for the important machinery that the Corporation proposed to install. In a public statement made after the Corporation's decision, Mr. D. H. Dunlop, director of B.E.A.M.A., said: "The National Scheme is in danger of becoming a happy hunting ground for retailers of foreign plant. The differences between the British prices for the Stockport Corporation contract and that of the Swiss firm which was accepted was £17,000. The offer of this Association to treat further in the matter to save the contract for British labour was ignored by the Town Council. We maintain that British plant on an efficiency basis justifies itself at a price 80 per cent. above that of foreign plant, quite apart from all considerations of employment, national production and national taxation. There ought to be some form of public inquiry into the circumstances in which contracts are placed abroad for generating plant by Corporations like those of Edinburgh, Newport (Mon.), York and Stockport. The British manufacturer has nothing to fear from any such inquiry that might be held."

£750,000 Bridge Proposal.

Although a long way from the adoption stage, the proposal to construct a bridge across the estuary of the river Ribble from a point about a mile above Lytham to Hesketh Bank on the other side of the estuary, has been carried a stage further by a conference at St. Annes of a number of local authorities in Lancashire which would be directly interested in such a scheme. The proposal is to construct a double-level bridge, about 2¼ miles in length, the higher level to carry a roadway capable of taking heavy modern traffic, and the lower level to deal with passenger transport by means of the "rail plane" system of cars. The estimated cost of the bridge is in the neighbourhood of £750,000. Plans were submitted to the conference by Mr. G. Bennie, of the George Bennie Railplane Trust, Glasgow. Possible objection to the proposal may be made by Preston Corporation, the navigation authority for the Ribble Estuary, which requires a clearance of 181ft. against the proposed clearance under the "Bennie" scheme of 85ft. above high-water mark.

Gasholder Explosion Inquiry.

The Ministry of Health inquiry into the explosion which occurred on August 23rd of last year at the Bradford-road gasworks of the Manchester Corporation was opened here by Mr. F. O. Stanford on February 2nd, and was adjourned for three weeks after general and expert evidence had been given, the witnesses including Mr. E. L. Rhead, head of the metallurgical department at the Manchester College of Technology, and Professor H. B. Dixon, Honorary Professor of Chemistry at the University of Manchester. Two of the four holders, which were erected in 1878, were destroyed as the result of the explosion, and seventeen people were injured. Mr. Rhead, who had carried out a series of tests on metal from the holders after the explosion, said that if he had examined the metal on August 22nd, he would not have advised putting the holders out of commission. If, however, he were asked whether such metal should be put into a new holder, he would say "No." The metal would pass muster according to the accepted standards at the time of erection. Professor Dixon said that he could not accept the theory that the escaped gas travelled a distance of 280 yards, and became ignited at the retort house. It was possible, he said, that gas was blown that distance and reached a flame, but it seemed incredible that it could have fired backwards to light the gas coming from the wrecked gasholder itself. A spark due to the friction of rupturing metal might have caused ignition, but it would have to be a rather big spark. There were instances, he believed, of that kind of spark being produced on iron with a pick.

Gas Plant for Warsaw.

A contract for coal-carbonising plant for Warsaw, valued at £130,000, has just been placed with West's Gas Improvement Company, Ltd., Miles Platting, Manchester, and a switchgear contract, valued at £94,000, for Sydney (N.S.W.) Town Council, has been placed with Ferguson Pailin, Ltd., electrical engineers, Openshaw, Manchester.

Non-ferrous Metals.

Reduced American demand for tin and expectations of relatively good supplies of the metal have again brought tin into prominence on the non-ferrous metals market during the past week. Values have sustained a further serious loss, and particularly during the opening days of the present week. Naturally, under present market conditions, trade buyers of the metal are operating very cautiously, and the position is probably too speculative, even for the professional element to venture very freely. The outlook is anything but clear, though the "bulls" are making the most they can of forecasts of renewed activity in the American tin-plate industry, which is responsible for a very big share of the world's tin consumption, during the next few months. Apart from a certain amount of buying of copper for use in the cable-making industry there has not been a great deal of activity in this section of the market, and with fairly plentiful supplies of the metal available values have experienced a decline. Spelter has lost ground during the week to the extent of 5s. or 6s. a ton on a continued quiet demand, although so far as can be seen there has been no undue anxiety on the part of holders to unload stocks. Of lead there is little that need be said. The demand from consuming interests has been on rather quiet lines, and further easiness has been displayed since last report.

Iron.

Conditions on the market for foundry iron here this week have been decidedly patchy, and, on the whole, there are not many bright spots about at the moment. One hopeful factor, from the point of view of sellers of the metal, is that weak holders of pig iron are not so prominent as they have been, and little, if any, further fresh weakening has occurred. One hears of several instances where consumers are taking advantage of the present low level of prices to cover their requirements for several months in advance, but, generally speaking, there is no disposition so far as the bulk of users are concerned to allow their pig iron commitments to extend much beyond what is justified by the state of their order books. An improvement in conditions at some of the machine tool

making establishments, it is satisfactory to note, has been succeeded by rather extended buying of pig iron, but these cases, unfortunately, are not too plentiful at the moment. Staffordshire No. 3 iron is quoted for delivery in the Manchester area at about 72s. per ton, with Derbyshire at 72s. to 72s. 6d., Middlesbrough at about 78s., Scottish from 87s. 6d. to 88s., and hematite at 84s. 6d. per ton. Prices for Lancashire bar iron keep steady at £10 per ton for Crown quality bars, £9 10s. for seconds material, but the demand for this remains on a very unsatisfactory scale.

Steel.

A somewhat brighter view is being taken just now of the outlook for the steel trade in this area, although it must be admitted that so far there is little of a tangible nature that one can point to. Constructional engineers locally keep fairly busy on work in hand. There has been a lull, however, in fresh inquiry in this section, though with several important schemes on the point of being launched in Manchester and district, a renewed flow of inquiries will probably be experienced before long. Current buying in the steel market is almost wholly of a hand-to-mouth character still, with chief interest being shown in joists and sections and general plates, offers of which keep steady at £7 12s. 6d. and £8 7s. 6d. per ton respectively. Boiler plates are in quiet demand, and although easy are about unchanged on the week at from £9 15s. to £10 5s. per ton, according to quality, with bars in a similar position at from £7 7s. 6d. for the small sizes up to £8 12s. 6d. for the large diameter materials. Although there is only a moderate demand about for imported steel and merchant competition is still acute, continental makers have firmed up quotations for delivery here, joists being quoted at about £5 12s. 6d. per ton, ordinary plates at £7 2s. 6d., Siemens plates at £7 12s. 6d. billets at £5 2s. 6d., sheet bars at £5 5s., and bar iron at £6 2s. 6d. to £6 5s. per ton.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade continues to be dull. The amount of business is not great, and stocks are not coming down as fast as one might hope. The present state of trade is to a certain extent due to competition by other districts, but this will not last for ever, and as soon as there is a re-adjustment of prices elsewhere, it is thought that the North-West District will to some extent come into its own. Business is confined, as far as moderately heavy tonnage is concerned, to the Midlands and Scotland, with South Wales taking small deliveries. There is nothing much being done with America, and trade with the Continent is only meagre. A cargo of pig iron went to Antwerp last week from Barrow. The iron ore trade is fairly employed, but there is much room for improvement, as trade is mostly confined to local requirements. There is not a great amount going on in the district. The steel trade is quiet, and fresh orders will be welcomed. At Workington the mills are engaged upon railway material, and at Barrow the rail, merchants, and hoop mills are operating, as are also the Siemens'.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trades.

CONDITIONS continue very variable in the heavy departments of the steel trade. While the majority of the producers of crude steel and iron, as well as the rolling mills, find trade very depressed, some of the manufacturing departments have a better report to make. The works of Vickers at Brightside are exceptionally well placed, being able to run full time in nearly all departments, and to find regular employment for upwards of 5000 persons. The activity of the electrical trade is proving of considerable help to them, and they book a good share of any armament work that is moving. Several orders for shells have been placed in Sheffield recently. Other firms engaged in the heavy steel section are also doing a fairly brisk trade.

In Lincolnshire.

The great steel-producing centre of Lincolnshire is rather better employed than it was before the Christmas holiday, but the position generally is far from good. One of the huge open-hearth furnaces at the Appleby works is running, while the Frodingham Company has four in operation, and Lysaghts have five. There is optimism with regard to the future, and this is evidently shared by the London and North-Eastern Railway Company, which is carrying out considerable extensions at Frodingham. There are already 19 miles of sidings there for merchandise traffic, and 11 more miles are being laid down, in addition to which a new station is being erected. Since 1913 the volume of traffic handled at that centre—consisting chiefly of ore, coal, iron and steel—has more than doubled.

Good Railway Orders.

A number of good railway orders, which will benefit local firms, have been placed during the past week. Cammell Laird and Co., Ltd., are to build at their Nottingham works 1500 all-steel bogie wagons for the Central Argentine Railway, half of them being covered, and the other half high-sided open wagons. Cravens' Railway Carriage and Wagon Company, of Sheffield, is sharing with the Midland Railway Carriage and Wagon Company—in which Cammell Laird has a controlling interest—an order for 700 sets of wagon ironwork for the London and North-Eastern Railway Company. The same company has also placed contracts for 690 open-spoke and 6730 disc wagon wheels and axles, with a number of firms, including John Baker and Co., of Rotherham; the Leeds Wheel and Axle Company; and the Newlay Wheel Company. The last-named is another company in which Cammell Lairds are interested. The extension of the use of steam rail coaches in Ireland has resulted in Clayton Wagons, Ltd., of Lincoln, receiving instructions to put in hand six units of its patented steam rail coach, specially designed to suit the particular requirements of the Great Southern Railways of Ireland.

Grinding Machine Activity.

Taskers' Engineering Company, of Sheffield, is well employed at present, and has sufficient orders on hand to keep its workmen busy for the next six months. The work in progress consists largely of the manufacture of grinding machines. It is supplying to a well-known local steel firm a new type of plant for grinding manganese steel rails, fitted with an extra head for angular work. The machine, which is made throughout of Sheffield steel, weighs about 23 tons. The bed is 24ft. long, the height 9ft., and the width 10ft. It has a capacity of 16ft. by 4ft. by 20in., and it is possible for about six rails to be ground at one time. All the motions of the head and table are automatic, and the head is fitted with micrometer feeds for down and cross work. Hand motions are also fitted for operating the cross table. Other orders which the firm has on hand include one for three 30-ton roll grinders.

The Lighter Trades.

The crucible steel trade is still poorly employed, while best quality tool steels are not selling well, and the demand shows little prospect of improvement. The position with regard to various products of steel, including tools, is more hopeful. Trade seems to be hardening, and it is anticipated that this year will show an advance on 1927. The production of stove grates and other building ironwork has fallen off greatly since the spring of last year, owing to the decline in the building of houses of the villa type. Certain types of fire-places are now listed at 40 and even 50 per cent. below former prices, and there has been a corresponding fall in the cost of other ironwork. The cutlery and plate trades continue to show improvement, and the output of the last few months has been considerably in advance of the standard of recent years. Cabinet case makers report that good class work is in better demand than for several years past, while the call for small and cheap cases is on an enormous scale. One Sheffield firm of cutlery case makers has received an order for no fewer than 30,000 oak cabinets to hold wireless sets and gramophones. This is the largest order of the kind ever placed.

Stainless Steel for St. Paul's.

One of the manufacturing trades of Sheffield which maintains its position very well is that concerned with stainless and rustless steels. New openings for the employment of these materials continue to be found, and the demand is an increasing one. Such materials have already been used to a large extent in the restoration work at St. Paul's Cathedral, and two new instances of its application are to hand this week. The firm of Brown Bayleys' Steel Works—which, by the way, has acquired the recently closed premises of S. H. Burrows and Sons, South Yorkshire Ironworks, for extension purposes—is engaged on the manufacture of a stainless steel chain which is to encircle the outer base of the dome of the Cathedral, and which is to be embedded in concrete, to strengthen the dome and preserve its shape. It will be the largest chain ever made of stainless steel, and will be 450ft. long, with a weight of 30 tons. Each link will be 15ft. 4in. long and 3¾in. wide. The links will be laid in four parallel lines. The chain will have a working load factor of 1000 tons. Thos. Firth and Sons, Ltd., whose Firth-Staybrite steel has been extensively used in the repairs to St. Paul's during the last two years, have now received further large orders for big tie-bars of that material, which are to be used in bracing the masonry together.

A New High-speed Steel.

It is announced by Edgar Allen and Co., Ltd., that they will shortly place on the market a new super-high-speed steel. Their works magazine states that it "is a really remarkable steel, and is made by the new high-frequency electrical process. Official tests have shown that it gives a much better result than any other steel we have ever manufactured, and we are hopeful that it will find a ready sale, even though its price at first sight seems high."

Exhibition of Sheffield Work.

In order to provide citizens and visitors from other towns with an opportunity to view the highly skilled work which is done in Sheffield, an exhibition of workmanship is to be held in the Cutlers' Hall from May 12th to 19th next. The arrangements are being made by a strong executive committee, representative of the Cutlers' Company, the Chamber of Commerce, the University and the trades' technical societies, with the Master Cutler as chairman. The exhibition is not to be confined to finished articles, but will, it is hoped, illustrate all stages of manufacture. In order to increase its attractiveness, there will be a continuous demonstration of many of the industrial processes carried on in the city, including the production of files and stainless table knives, and the making of crucible steel.

A Growing Electrical Undertaking.

The electric supply undertaking of the Sheffield Corporation has made remarkable strides in recent years. Whereas the number of units sold in 1914 was 26½ millions, the figure for 1927 exceeded 170 millions. Last week a new 15,000 H.P. turbo-alternator at the Neepsend power station was formally started by the Lord Mayor. It cost £28,000 and will replace an obsolete apparatus and permit an increased output, without corresponding increase of buildings, boilers and other auxiliaries. It weighs 92 tons, and runs at 3000 revolutions per minute. The engine-room at Neepsend now accommodates plant which will generate 78,000 kW.

Orders for Aircraft.

The Blackburn Aeroplane and Motor Company, of Leeds and Brough, is to build three Blackburn Rolls-Royce flying cruisers for the Air Ministry. It is understood that the new boats will be similar to the Iris II., which the company launched at Brough last August. This machine, which is almost entirely constructed of metal, and can remain in the air for at least fourteen hours, was described at the time as the largest flying warship in the world.

NORTH OF ENGLAND.

(From our own Correspondent.)

Tees Bridge Design.

EXCEPTION has been taken by the Tees Conservancy Commissioners to the design of the proposed bridge across the river Tees at Newport, Middlesbrough, which has received the formal approval of the Middlesbrough Corporation and Durham County Council. The intended bridge, which is estimated to cost £500,000, shows a clear headway of 160ft. above high water of ordinary spring tides—the same as that of the Middlesbrough Transporter Bridge—and a width between piers of 200ft., as in the case of the Tower Bridge, London. The consulting engineer, Colonel Barry, reporting upon the plan, has advised the Commission that, provided the pier on the Yorkshire side of the river was moved shorewards for 50ft., thus making a clear channel of 250ft., the construction of the bridge would not be likely prejudicially to affect the interests of the river, either from silting or interference with the free movement of tidal water, and could not be reasonably objected to from a navigation point of view. The Commissioners, however, are apprehensive that, owing to the great weight of roadway to be lifted at each opening, the bridge would be liable to stoppages in working, and would thereby endanger the public navigation of the river. The Commissioners have decided to refer their observations to the consulting engineer, and also to call a conference with representatives of the Middlesbrough Corporation and the Durham County Council to discuss the design of the bridge.

Iron and Steel Imports.

The fact that Cleveland iron and steel manufacturers are at last successfully counteracting the foreign competition in the home market is reflected in the statistics of imports presented at this week's meeting of the Tees Conservancy Commissioners. During the past three months—November, December and January—the imports were the lowest recorded for many years past, as compared with the corresponding periods. They totalled 57,270 tons, as compared with 112,675 tons in the corresponding period of 1926–27, and 17,119 tons in the pre-war period. Pig iron imported during the three months totalled only 3327 tons, as against 44,125 tons in 1926–27, and 50 tons in 1913–14, while 41,928 tons of crude sheet bars, billets, blooms, &c., were imported as compared with 52,489 tons and 11,200 tons respectively. The imports of plates, bars, angles, sheets, joists, &c., reached 12,015 tons, as compared with 16,061 tons in 1926–27 and 5869 tons in 1913–14.

Cleveland Iron Trade.

Home and Scottish demand for Cleveland pig iron continues active, with forward business plentiful, and producers have now quite good order books. There are, however, continued complaints that current rates for pig iron—and especially hematite descriptions—remain altogether unremunerative; but hope is entertained that conditions will shortly justify ironmasters in re-kindling more blast-furnaces thereby reducing working expenses. In the meantime, apprehension is expressed that a shortage of Cleveland pig iron may cause inconvenience to customers in the near future unless output is enlarged. Stocks are now at a very low ebb, and production is insufficient to meet requirements. Continental competition is becoming appreciably less keen, owing, to some extent, to increasing cost of production at works abroad. In this respect the Swedish ore trade dispute is of significance, its tendency being further to send up the price of iron products on the Continent, and in Germany especially. At the moment sales of Cleveland pig iron are still mostly to home firms and to buyers in Scotland, but overseas business while still small, shows some expansion and export inquiries encourage the belief that transactions for despatch to foreign ports are likely to be on a much improved scale in the near future. Prices are not quotably changed, but the tendency is markedly upward. Makers' fixed rates are:—No. 1 foundry, 67s. 6d.; No. 3 G.M.B., 65s.; No. 4 foundry, 64s.; and No. 4 forge, 63s. 6d. per ton.

Hematite Pig Iron.

Supply of East Coast hematite pig iron continues ample, but both home and continental demand is just a little better, and there seems promise of further improvement. Parcels being disposed of are very largely of iron to special analysis to suit customers' particular purposes, but quotations are still based on the price of mixed numbers, which is in the neighbourhood of 70s.

Iron-making Materials.

Ore shipments to the Tees have declined owing to the dispute in Sweden, but consumers have very large stocks, and are taking heavier deliveries of Spanish and Algerian ores. Values are very firm, best Rubio being put at 21s. per ton c.i.f. Tees. Consumers of Durham blast-furnace coke are rather more disposed to negotiate for supplies, but the volume of business passing is far from heavy, and prices asked are still on an unprofitable basis. Good medium qualities are stated to have realised 17s. 9d. per ton delivered at the works.

Manufactured Iron and Steel.

Business in manufactured iron and steel is expanding on a satisfactory scale. Continental semi-finished and finished steel prices are now moving upward—an event that assists manufacturers in this area to book more home orders, and also to compete successfully

for the recapture of lost markets abroad. Quotations for the products of this area are steady.

The Coal Trade.

The outlook in the Northern coal trade is irregular, but, generally, the position points to a slow but improving tendency. For two or three weeks ahead most of the fitters report a well-filled order book, and quote very steadily for all positions. There is a strong inclination amongst speculators to hold off the market in view of possible labour troubles on the Continent between March and May, as many labour agreements are due for renewal, and most of the labour organisations are pressing for more favourable terms. Stoppages on the Continent are quite a possible development, and this causes a reserved policy to be favoured in the Northern market. There is also a disposition on the part of buyers to feel their way cautiously in case the result of the wages arbitrations in Northumberland and Durham should have any effect on the general range of quotations. All classes of Northumberland steams have a steady appearance, and up to 14s. is named for best qualities, with second qualities at 11s. 9d. to 12s. Steam smalls continue plentiful, and prices are unchanged, though rather easy. Coking unscreened coals are quiet for prompt and nominal forward, but buyers expect a substantially improved demand setting in from continental buyers, and therefore are marking time. Quotations are firm at 13s. 6d. to 14s. Durham gas fuel is in fair average demand, but sellers are numerous at 15s. 4d. to 15s. 6d. for best qualities and secondaries at 13s. 6d. to 13s. 9d. There is an improvement in the demand for coke. Gas qualities have had a long period of activity, and show no signs of easing off. Best makes are firmly quoted at 23s. Patent oven cokes meet a much improved demand, both for home and export. Prices have hardened to 18s. 6d. for ordinary and 24s. to 25s. for specials.

Shipbuilding.

Palmers Shipbuilding and Iron Company, Ltd., Jarrow and Hebburn, has booked an order for two passenger steamers for the Polish Government. The vessels, it is understood, will be laid down in the Jarrow yard. They are not of large size, and are intended for service in the Bay of Danzig. The vessels, however, will prove a welcome addition to the work now in the hands of the company, which has been very successful during the past two years in booking work from abroad. Rapid construction is proceeding with the work in hand in all the North-East Coast yards, but more orders are required to ensure a period of continued work.

SCOTLAND.

(From our own Correspondent.)

Contract for Glasgow Firm.

MESSRS. DUNCAN STEWART AND CO., a well-known Glasgow engineering firm, have secured the contract for the installation of a sugar refinery at Umbelugi, in Portuguese East Africa. The contract is estimated at between £270,000 and £300,000, and will, it is said, provide work for twelve months.

Ironworkers' Wages.

By a recent decision of the Scottish Steel Industrial Conciliation Board, alterations in wages will take place next week. The wages of the workers in the manufactured iron and pig iron sections will be reduced by 5 per cent., while wages of men in the steel manufacturing sections will be increased by 1¼ per cent.

Steel.

There is little change in the position of the steel trade. The majority of the works are in operation, but in very few cases is full time being worked. Railway and electrical orders have helped matters a little, but shipbuilding demands continue to disappoint. The upward movement of foreign prices of steel is a more hopeful sign even although the disparity between those and home rates still remains considerable. Home prices are unchanged.

Iron.

Bar iron continues quiet, but there has been a better demand for tube strip. Re-rolled steel bars and tube hoops are inactive. Bar iron and re-rolled steel for home delivery are unchanged at £10 and £7 15s. per ton, while for export the quotations are £10 and £7 per ton respectively.

Tubes.

Seamless tubes are in good request at present. Butt-welded tubes are busy despite keen competition, but makers have still to depend to a large extent on foreign raw materials.

Pig Iron.

There has been no improvement in the pig iron industry. Supplies are ample, but some makers do not consider the prices obtainable to be remunerative, and prefer to hold stocks rather than sell while prices are unchanged.

Exports and Imports.

Iron ore to the amount of 7050 tons was discharged at Glasgow during the past week, and within the same period 2300 tons of iron and steel and 720 tons of steel plates. Iron and steel shipments amounted to 3300 tons, about two-thirds of which went to China, Japan, New Zealand and Calcutta.

Coal.

A weaker tone is apparent in the Scottish coal market. Apart from Lanarkshire splints, which are well booked for delivery this month, most descriptions of fuel are in need of fresh business, and prices show an easing tendency. Shipping demands are very restricted, and a good prompt order can obtain advantageous terms. The home market likewise is disappointing. Neither industrial nor household requirements approach normal. Aggregate shipments from Scottish ports during the week amounted to 188,364 tons, against 226,525 tons in the preceding week and 232,235 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position so far as the steam coal trade in this district is concerned is by no means satisfactory, and the conditions in the anthracite section are very little different. Shipments are proceeding on a fairly good scale, but they cannot be described as active. The total amount of coal shipped last week was a slight improvement upon the figures for the preceding week, inasmuch as the quantity was just over 402,000 tons, as against rather more than 392,000 tons. This fluctuation may have been due entirely to the tonnage factor, which is very important. Steamers are being delayed very considerably by the bad weather, and as a consequence, are getting out of position. At the end of last week there were as many as 44 idle loading appliances at the various docks in this district, and on Monday, as the result of tonnage arrivals over the week-end, the number of idle loading appliances was reduced to 26, but unfortunately this total will in all probability be materially higher before the week is out. Practically no progress is being made towards a real reduction of inactive appliances, and one week is very much like its predecessors. There were recently some indications of an expansion in operations in steam coal, and everyone felt that there was a better foundation to the coal market, but unfortunately this slight improvement seems to be fading away. Whether the proposed scheme for the stabilisation of prices had anything to do with this is problematical, but no one now appears to think that this scheme is likely to be introduced before March, whereas not long ago the report was that it was expected to be brought into operation early in February. At the moment there are extremely few important contracts about. The Portuguese State Railways recently asked for prices for supplies of fuel, but it is understood that German competitors have undercut local firms by at least one shilling per ton. In the case of their inquiry for 100,000 tons of steam small coals for delivery over three or four months from about March next, it is practically certain that this business will go to a concern closely associated with one of the largest local combines, as it is known that it has put in the lowest prices. Intimation has also been received that the Egyptian State Railways are coming on to the market for over 300,000 metric tons of large coal for delivery over this year from about the end of April. Specifications have not yet been received, so that the exact quantities and periods are not known. During the past year or so these railways have only bought quantities of about 100,000 tons for delivery over three months, and it is quite possible that they may follow this procedure rather than purchase the full quantity over the whole of the remainder of this year.

Coal Bunkering and Docks Items.

A welcome announcement was made at the Cardiff Chamber of Commerce meeting on Friday in last week by Mr. C. S. Page, the chief docks manager of the Great Western Railway Company. This was that the company had decided to revert to the pre-war charge of 4d. per net register ton in the case of vessels calling at local ports for bunkers only. This arrangement was to come into operation on Monday, the 6th inst. The charge previously had been 6½d. per net register ton, so that the concession is a material one. Hopes are entertained that a good deal of the bunkering business will be recovered from continental and other districts as a consequence. It is also reported that progress has been made between the traders and the G.W.R. officials regarding the arrangement for securing the concession that vessels may change from one of the company's docks to another by the payment of a single docking rate and locking fee in place of paying the full rates operative at both docks. It is expected that before very long a further announcement on this subject will be forthcoming. It is understood that the locking fee is approximately a quarter of the dock dues operative, but in some quarters this is held to be rather too high. With regard to the movement for arranging for a joint deputation of the coalowners and representatives of the miners to wait on the Prime Minister on the question of a reduction in railway rates and dock charges, this matter came up for consideration by the Executive Council of the South Wales Miners' Federation on Monday, when owing to letters which had been received from some of the districts, it was decided to call a coalfield conference on the 27th inst. so that a report on the subject could be given to the miners' delegates.

Portuguese Railway Contract.

Contrary to expectations, the Portuguese State Railways have not yet placed their contract for 100,000 tons of small coals for delivery from March over a period of three or four months. Rumours are current that they may call for fresh tenders.

The Tin-plate Trade.

The decision of the tin-plate manufacturers in this district not to continue the *ex gratia* bonus of 3½ per cent. hitherto participated in by 90 per cent. of the employees, while willing to continue the bonus of 7½ per cent. to the lower paid men, has caused considerable dissatisfaction to the workmen. The employers' contention, of course, is that the state of trade does not justify any further concession, whereas, on the other hand, the men's contention is that the recent slight improvement in the trade warrants its continuance. There was a fully attended meeting of the men's side of the Welsh Tin-plate Joint Industrial Council at Swansea on Monday, when the matter came up for consideration. A resolution was passed strongly opposing the employers' decision, and the officials were instructed to raise the question at the Standing Joint Committee to be held on the 13th inst. It was further decided to call upon the affiliated unions to render their assistance in an effort to resist the action of the employers.

Ship-repairing Order Lost.

Another substantial ship-repairing order has been lost to this district, this making the fourth this year. In this case it concerns the Cardiff-owned steamer "Lady Charlotte," which was on Tuesday expected to proceed from Penarth to South Shields in order to go through her first No. 3 survey. Tenders were invited for the work from South Wales and other United Kingdom firms, and the price submitted by the Middle Dock Company, South Shields, was so much below the lowest tender of a local firm that the work had to go to the North. The lowest price from the Bristol Channel was £5289, the work to be carried out in thirty-two days, whereas the tender of the successful firm was £3950, and the work to be completed in twenty-two days.

Current Business.

The tone of the market is quieter and the inquiry coming from abroad is far from being on an active scale. Some of the collieries are fairly busy on the strength of business arranged some time ago, but there is scarcely a section in which collieries are not working rather indifferently, and finding it difficult to carry on. The irregularity of the work at many pits is responsible for the small coal market continuing to be very steady for the superior grades and sized coals maintain a good tone, but large coals are uneven and easy for prompt loading. The demand for patent fuel shows no material expansion, and pitwood is a shade easier.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

LEWENZ AND WILKINSON, Ltd., of 25, Victoria-street, Westminster, S.W. 1, ask us to announce that they have been appointed sole agents for Great Britain and Northern Ireland for Messrs. Keiser and Schmidt, of Charlottenburg, for the sale of pyrometers and resistance thermometers.

MAYOR AND COULSON, Ltd., of 47, Broad-street, Mile End, Glasgow, S.E., ask us to announce that Mr. William Rea has left their service and that Mr. J. Ditchfield, of 18, Parr's Wood-road, Withington, Manchester, has been appointed as their switchgear and control gear representative in the Lancashire, Yorkshire, North Wales, and Midlands districts.

RICHARD GARRETT AND SONS, Ltd., of Leiston, ask us to announce that Mr. G. Percival Ellard late London sales manager of the Sentinel Waggon Company, Ltd., has been appointed as sales manager and organiser of their steam wagon department, and that Mr. O. H. Gardner, late overseas sales manager for Petters, Ltd., Yeovil, has been appointed their sales manager and organiser for all products other than steam wagons.

KELVIN BOTTOMLEY AND BAIRD, Ltd., of 18, Cambridge-street, Glasgow, ask us to announce that, in consequence of the death of the late Mr. Alfred William Baird, their nautical department will in future be co-ordinated under the direction of Mr. Samuel B. Wilson, who has been in the employment of the company for thirty-four years, was at one time closely associated with Lord Kelvin in electrical laboratory work, and for many years past has superintended under Mr. Baird the internal section of that department.

CONTRACTS.

THE OGDEN ENGINEERING COMPANY, of 2, Blue Boar-court, Market-place, Manchester, has received orders for two complete air-conditioning plants, each fitted with automatic controlling apparatus, to be fitted at a mill in Lancashire for one of the leading artificial silk manufacturers.

THE GENERAL ELECTRIC COMPANY, Ltd., of Magnet House, Kingsway, London, W.C. 2, has received the following orders:—(*a*) From Elder, Dempster and Co., Ltd., for the supply of "Osram" vacuum, gas-filled and carbon filament lamps during 1928; (*b*) from H.M. Admiralty, for 11,000 "Osram" vacuum and carbon filament lamps; (*c*) from the Dublin United Tramways Company, for 10,000 "Osram" vacuum and gas-filled lamps; and (*d*) from H.M. Admiralty, for 11,500 special Admiralty pattern "Osram" metal filament and carbon filament electric lamps.

JOHN I. THORNYCROFT AND CO., Ltd., have received an order to supply a twin-screw motor cattle transport vessel, to be named "Bovril," for the Argentine Estates of Bovril, Ltd. This is the fourth vessel for this class of work supplied by the firm to the same owners. The new vessel will be of the following general characteristics:—Length, 160ft.; breadth moulded, 36ft.; depth moulded, 7ft. 6in.; draught (loaded), 5ft. 9in.; speed, about 10 m.p.h.; and power, 40 B.H.P. The vessel will have accommodation for about 700 live cattle, and will be used for transporting them from the Estancias to the Bovril factory on the Parana River, Argentine.

INSTITUTION OF MECHANICAL ENGINEERS.—On Friday evening, February 3rd, the graduates of the Institution of Mechanical Engineers held a conversazione in the Institution building. An excellent programme of music was provided and a number of films were exhibited in the lecture theatre. About 250 graduates and their friends were present, and the evening was an undoubted success. We believe that this is the first time that anything of the kind has been attempted by the graduates. As it brought together many young engineers and even introduced some to the Institution building for the first time, it may be regarded as an experiment worthy of repetition.

CONSULTING ENGINEERS TO THE GOVERNMENT OF INDIA.—We understand that the consulting engineers to the Secretary of State for India in Council and to the High Commissioner for India—Messrs. Rendel, Palmer and Tritton, of Dartmouth-street, Westminster—will, at the request of the Government of India, open a branch office in Calcutta during next cold season. The work will be of a professional and advisory nature, the branch office acting as a liaison office between India and London, thus enabling many important projects, such as the designing of new and the rebuilding of existing bridges, the standardisation of locomotives and rolling stock, and the results of universal tendering, &c., to be considered on the spot.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 9 6	3 9 6
No. 1	3 10 0	3 10 0
Cleveland—		
No. 1	3 7 6	3 7 6
Silicious Iron	3 7 6	3 7 6
No. 3 G.M.B.	3 5 0	3 5 0
No. 4 Foundry	3 4 0	3 4 0
No. 4 Forge	3 3 6	3 3 6
Mottled	3 3 0	3 3 0
White	3 3 0	3 3 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 4 6 to 3 6 0	—
(3) Northampton—		
Foundry No. 3	3 0 0 to 3 1 0	—
Forge	2 14 0	—
(3) Derbyshire—		
No. 3 Foundry	3 4 0 to 3 4 6	—
Forge	2 19 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 4 0	—
No. 4 Forge	3 2 6	—
Basic	3 2 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (a) / 4 5 0 (b) / 4 8 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	10 0 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 5 0	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0	—
Gas Tube Strip	11 10 0	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¾in. and up	8 2 6	7 12 6
Sections	7 12 6	7 2 6
Steel Sheets, ¼in.	8 12 6	8 15 0
Sheets (Gal. Cor. 24 B.G.)	13 12 6	13 7 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 2 6	—
Angles	7 12 6	—
Boiler Plates	12 10 0	—
Joists	7 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
MANCHESTER—		
Bars (Round)	8 10 0	—
,, (Small Round)	7 10 0	—
Hoops (Baling)	10 5 0	10 0 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 7 6	—
,, (Lancs. Boiler)	10 5 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 12 6 to 8 2 6	—
Intermediate Basic	7 10 0	—
Soft Basic	6 10 0	—
Hoops	9 10 0 to 10 10 0	—
Soft Wire Rods	9 0 0	—
MIDLANDS—		
Small Rolled Bars	7 7 6 to 8 0 0	—
Billets and Sheet Bars	6 0 0 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 0 0 to 13 5 0	—
Angles	7 12 6	—
Joists	7 12 6	—
Tees	8 12 6	—
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	17/10½ to 18/1½
Block Tin (cash)	238 15 0
,, (three months)	240 5 0
Copper (cash)	62 0 0
,, (three months)	61 10 0
Spanish Lead (cash)	20 16 3
,, (three months)	21 6 3
Spelter (cash)	25 16 3
,, (three months)	25 16 3
MANCHESTER—	
Copper, Best Selected Ingots	66 15 0
,, Electrolytic	67 0 0
,, Strong Sheets	92 0 0
,, Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 1 0
,, Condenser, lb.	0 1 2
Lead, English	22 10 0
,, Foreign	21 5 0
Spelter	25 15 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/7½ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 7 6	7/-
,, ,, 8 p.c. to 10 p.c. ,,	£22 5 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£35 10 0	11/6
,, ,, ,, 1 p.c. carbon	£41 10 0	15/-
,, ,, ,, 0·70 p.c. carbon	£53 0 0	17/6
,, ,, ,, carbon free	1/2 per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£13 10 0 for home	
	£13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 17 6 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/- per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£175	
Ferro-Cobalt	9/- per lb.	

FUELS.

SCOTLAND.
(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/6
,, ,, Ell	16/-
,, ,, Splint	16/6 to 17/6
,, ,, Trebles	14/3
,, ,, Doubles	13/9 to 14/-
,, ,, Singles	11/6 to 11/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
,, ,, Jewel	15/6
,, ,, Trebles	14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/6
Screened Navigation	18/-
Trebles	14/- to 14/9
Doubles	13/9
Singles	11/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/9
Secondary Steam	12/3
Trebles	14/-
Doubles	13/6
Singles	11/3

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	23/6
NORTHUMBERLAND—	
Best Steams	13/9 to 14/-
Second Steams	11/9 to 12/-
Steam Smalls	10/-
Unscreened	11/9 to 12/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/6
Second ,,	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	18/6 to 19/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	27/6 to 29/6	—
Derbyshire Best Bright House	20/6 to 21/6	—
Best House Coal	19/- to 20/6	—
Screened House Coal	16/- to 17/6	—
,, ,, Nuts	15/- to 16/-	—
Yorkshire Hards	14/6 to 15/6	—
Derbyshire Hards	14/- to 15/6	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/- to 7/-	—
Smalls	3/- to 4/6	—
Blast-furnace Coke (Inland)	13/- at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		17/6 to 18/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/- to 19/6
Second Smokeless Large	18/6 to 19/-
Best Dry Large	18/3 to 18/9
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	17/- to 17/3
Western Valley Large	16/9 to 17/-
Best Eastern Valley Large	16/9 to 17/-
Ordinary Eastern Valley Large	16/3 to 16/9
Best Steam Smalls	12/6 to 13/3
Ordinary Smalls	11/- to 12/6
Washed Nuts	18/- to 23/-
No. 3 Rhondda Large	20/- to 20/6
,, ,, Smalls	14/9 to 15/3
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	30/- to 37/6
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	22/6 to 24/-
Pitwood (ex ship)	27/- to 27/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	30/- to 32/6
Seconds	25/6 to 29/-
Red Vein	20/6 to 25/-
Machine-made Cobbles	35/- to 40/-
Nuts	37/6 to 42/6
Beans	22/6 to 27/6
Peas	17/- to 18/-
Breaker Duff	8/6 to 9/-
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	10/- to 11/-
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 7/6 joists and 5/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Advancing Prices.

THE work of reorganisation which has been carried out in the continental iron and steel trades during the past year or two is beginning to have its effect in strengthening and consolidating the position of the industry. The Steel Union was unable of itself to secure the desired result by a limitation of production, but now that its operations are supplemented by *comptoirs* for the sale of steel products in foreign markets, the effect upon the trade is more noticeable than had been anticipated. Prices all round have advanced, and mill and forge owners are securing a good volume of orders, mainly on export account, to the extent that some of them refuse to quote further for future deliveries.

Electrification.

The reorganisation of the country's finances is having the effect that more attention is being given to the electrification and other schemes that have had to remain in abeyance through the State being unable to contribute its share of the expense. The programme, as originally presented, appeared so vast that it was difficult of realisation without the help of material supplied by Germany on account of reparations, and it is hoped that this will be forthcoming for the execution of the scheme which is to provide the country with an enormous economic advantage in the way of cheap energy. On the Dordogne a considerable amount of hydraulic energy is already being utilised, and the Senate has now passed a Bill authorising the grant of a concession between that belonging to the Paris-Orleans Railway Company and the Argentat Bridge. It is accorded to a company, the capital of which will be subscribed one-half by the Groupement Economique of that region and one-half by electrical distributors, manufacturers and other consumers. The cost of the installation is estimated at 328 million francs, and it will provide 600 million kilowatt hours per year, one-third of which will be distributed locally and the remainder will be available for Paris, where it will be supplied at 15 to 16 centimes per kilowatt hour. It is understood that the Paris-Orleans Company will draw upon this supply instead of utilising the concession on the Upper Dordogne.

Harbour Works.

In view of the preparations being made by shipbuilders on the Loire for building much larger vessels than those now constructed there, it has been found necessary to provide for the passage of bigger ships from the Loire to the port of Saint-Nazaire, where they will be fitted out. A dock, 350 m. long and 50 m. wide, will be constructed, and it will serve the double purpose of enabling the biggest vessels to pass between the Loire and the port and of being used as a dry dock in case of necessity. Railway Communication will be provided between the two sides of the dock by a swing bridge passing over one of the sluice gates. The estimated cost is about 80 million francs, which, it is expected, will be partly covered by material obtained from Germany on account of reparations.

The Seine Floods.

One of the original proposals for preventing inundations was to construct a canal between the Marne and the Seine to the north of Paris, but the expense was so great that the scheme was abandoned, especially in view of doubts that were expressed as to whether the canal would be really effective in faciliating the flow of water from above to below the city. The same objection is being made in some quarters against the utilisation of the Saint-Maur Canal for the purpose, but the technical commission believes that there is no ground for the protests being raised against the scheme by the local authorities on the Marne, and it has been decided to start work this year upon deepening the Saint-Maur Canal and joining it up with the subterranean canal at Joinville. This latter will be widened to 9 m. and deepened by 3ft., while the Saint-Maur Canal will be deepened by 3½ft. As this canal cuts off the bend of the Marne, it is estimated that it will reduce the water level at Joinville in times of flood by about 3ft. The canal also will be rendered navigable for big barges, for which purpose an extension lock will be constructed.

Navigation Signals.

A new system of signalling which, it is claimed, is likely to render the same service as the Loth cable for navigating ships into harbour during fog, has been experimented with for some time past at Havre. The inventor, M. Aicardy, a naval officer, employs two emission aerials, whereby two bands are made to overlap each other and neutralise effects in such a way that a "zone of silence," representing the width of the navigable channel, is created between them. A receiver on the ship shows by characteristic sounds when the vessels is moving away from the channel and the sounds increase in intensity with the distance, so that it is easy for the pilot to keep to the safe route. The signals are heard at a distance of from five to six miles.

Coal Production.

Notwithstanding the alleged unsatisfactory position of the colliery industry the coal output increased in 1927 to 52,846,698 tons, as compared with 52,477,522 tons in the previous year and 48,090,649 tons in 1925. The production of coke at the collieries also increased, the figures being 3,064,918 tons in 1925, 3,767,400 tons in 1926, and 4,068,208 tons in 1927. The imports of coal during the past year amounted to 19,008,192 tons. To this total Great Britain contributed 9,051,795 tons, Germany 6,281,649 tons, and Belgium and Luxemburg 2,347,174 tons, while amongst other countries the United States supplied nearly half a million tons. The German coal was on account of reparations, and Germany also furnished 3,416,910 tons of coke out of a total of 4,721,969 tons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

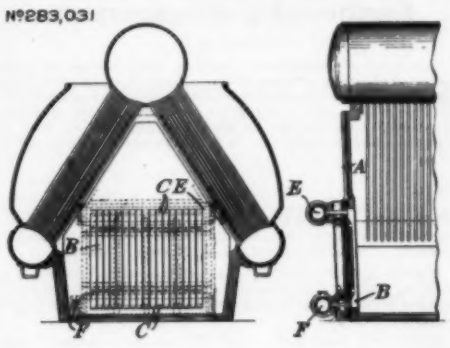
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

283,031. April 20th, 1927.—IMPROVEMENTS IN AND RELATING TO SUPERHEATER BOILERS, Thomas Edward Robertson, of 43–46, Southampton-buildings, Chancery-lane, London, W.C. 2.

According to this invention, a radiant heat superheater is incorporated in the wall A. The superheater is composed of channelled elements B, which may be rectangular and formed of

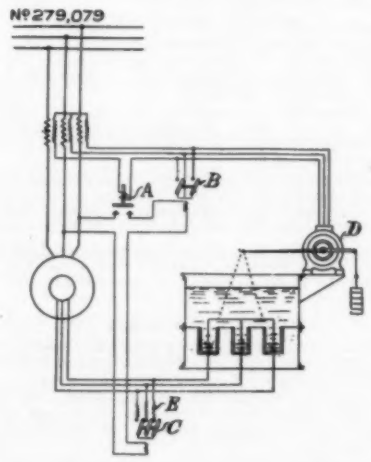


cast steel. Each element is connected at its ends through pipes C with external steam inlet and outlet headers E and F. The elements B are supported by a metallic framework. It is claimed that a relatively high superheating effect is obtained with a small amount of superheating surface, adequate space for which is available in the desirable position shown in the low portion of the combustion chamber end wall A.—*January 5th*, 1928.

DYNAMOS AND MOTORS.

279,079. October 11th, 1927.—IMPROVEMENTS IN OR RELATING TO AUTOMATICALLY OPERATED LIQUID SLIP REGULATORS FOR INDUCTION MOTORS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, United States of America.*

This specification describes a method of controlling a liquid resistance slip regulator for the rotor of an induction motor by intermittently operating the resistance regulating motor with increased torque when the desired current limit is substantially attained or exceeded. If the main current increases to a value in the neighbourhood of the current limit, the contactor A opens its contacts, so that the switches B and C open. As soon as that happens the motor D has a voltage applied to it and the parallel resistance E is rendered ineffective. The slip regulating

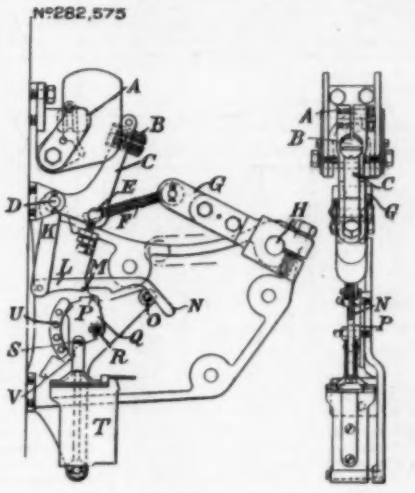


motor D therefore begins to work. The rotor resistance is increased by the opening of the switch C. This has the effect of anticipating a part of the slip regulator effect just at the moment in which the natural inertia of the slip regulator is most felt. As soon as the main current falls the contactor A closes its contacts at a certain current value below the limit, so that the switches B and C also close. By the closing of the switch B the motor D is again short-circuited. The motor therefore only receives a temporary voltage when the current limit is more or less approximately attained. Owing to this intermittent working the motor can be more heavily loaded than with the usual arrangements. By closing the switch C the resistance E is connected in parallel with the slip resistance.—*January 5th*, 1928.

SWITCHGEAR.

282,575. March 2nd, 1927.—IMPROVEMENTS IN AUTOMATIC CONTROL SWITCHES FOR ELECTRIC CIRCUITS, Whipp and Bourne, Ltd., of Switchgear Works, Castleton, near Manchester, and Frank Whipp, of the same address.

This invention relates to improvements in automatic control switches for electric circuits in which the control means, either hand or automatic, operating the closing or opening of a switch, are automatically locked from further actuation if the switch has operated a given number of times within a predetermined period. The description of the switch is as follows:—A fixed switch contact A in a circuit to be controlled co-operates with a movable switch contact B preferably adjustable on one arm of a bell crank lever C pivoted at D to the frame, and connected at E to one pivot of a toggle linkage F G, the other fixed pivotal point H of which may be arranged to be on the shaft oscillated by hand or by electro-magnetic means for the operation of the switch contacts A and B. Each oscillation of the shaft H brings the toggle linkage from the position illustrated in full lines to that illustrated in dotted lines, and the switch arm C is moved about its pivot D to close the switch and also to operate the rocking of an arm K about the pivot D, and the moving forward of a pawl arm L having a stop pawl M and a cam extension N, which co-operates with a fixed roller O on the frame. During the forward movement of the pawl arm L the pawl M will drop into engagement with one or other of the teeth P on a segment Q pivoted to the frame at R and connected at S to the piston of a dashpot T. The shaft H is an extension of the operating shaft of a main circuit breaker (not shown) which may be an electro-magnetically operated circuit breaker of the usual type. The shaft H is oscillated by an electro-magnetic device to open and close the main circuit breaker contacts, the operation by the notching device being a secondary operation dependent on the movement of the main breaker. The action of the device is described as follows:—When the main circuit breaker closes,

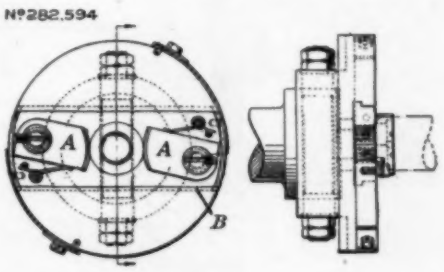


the shaft H is oscillated in a clockwise direction opening the contacts A and B of the device which remain in the open position until the main circuit breaker has opened, for any particular reason, when contacts A and B are again made, and in the action the levers K and L are moved forward. The inclined arm N runs down the roller O causing the pawl M to engage with a tooth P on the quadrant Q, which then rotates about R and raises the piston in the dashpot T. If the main circuit breaker is now closed and remains closed the piston in the dashpot is allowed to fall back to its ordinary position, but if the circuit breaker opens again before the piston has had time to fall to its full extent the above cycle of operations is repeated, the pawl M engaging the second tooth on the quadrant and raising the piston still further. The number of times this sequence of operations can take place can be varied as desired by placing a stop pin U in one or other of a number of holes in the segment according to the number of times the device is required to operate. If desired an extension piece V on the segment Q may have switching devices upon it, co-operating with a switch contact to break the circuit of the electro-magnetic device attempting to oscillate the shaft H of the main circuit breaker, thus locking the circuit breaker so that it is impossible for it to operate again until the notching device has been reset.—*December 29th*, 1927.

MACHINE TOOLS AND SHOP APPLIANCES.

282,594. June 8th, 1927.—LATHE CHUCKS, *E. C. R. Marks*, 57, *Lincoln's Inn-fields, London, W.C.* 2.

In the case of this driving chuck for lathe work the job is gripped by two serrated cam-like pieces A A, which are so formed and pivoted that the drive tends to increase their grip. The

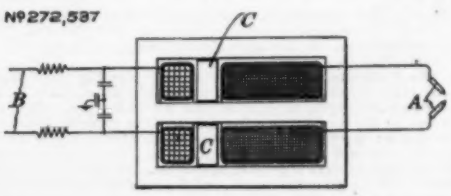


peculiarity of the arrangement lies in the fact that these two cam pieces are mounted on a radial slide B so that in the event of the periphery of the work piece not being concentric with its centres the drivers may accommodate themselves to its conformation and provide a driving force.—*December 29th*, 1927.

MOTOR CARS AND ROAD TRAFFIC.

272,537. June 10th, 1927.—IMPROVEMENTS IN AND RELATING TO ELECTRIC IGNITION SYSTEMS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

This specification describes an ignition circuit including a



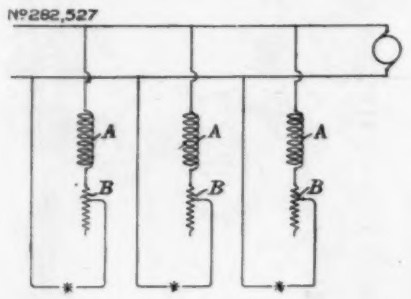
transformer having primary and secondary windings, a pair of spaced electrodes in the secondary circuit, and a magnetic shunt for leakage from the primary winding, whereby the transfer of

high-frequency oscillations from the electrodes to the primary winding is reduced. The object of the invention is to prevent the high-frequency currents interfering with radio reception. The electrical discharge between the electrodes A produces a high-frequency oscillation in the circuit which supplies current to the electrodes, and the oscillations may interfere with radio reception if they are permitted to reach the primary leads B, because they may travel back and spread through the house lighting system or other supply circuit. According to the invention, the trouble is prevented or substantially reduced by magnetic shunts C in the space between the two windings.—*January 5th*, 1928.

WELDING.

282,527. October 30th, 1926.—AN IMPROVED METHOD OF AND APPARATUS FOR OPERATING ELECTRIC ARC WELDING SYSTEMS, James Colquhoun Macfarlane, Braehead, Cathcart, Glasgow, and William Allan Macfarlane, Alderwood, Cathcart, Glasgow.

This specification describes an arc welding system in which a current supply at a constant potential higher than the voltage required to maintain the arc or arcs but lower than the voltage needed to start or strike the arc is used, the extra voltage required on the breaking of the circuit at the arc being provided by a choking coil. One of the schemes described is shown in the

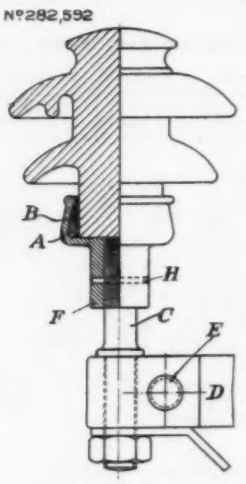


diagram, where there are three arc circuits, each comprising an air choking coil A and a resistance B. Each choking coil has a constant value which is sufficient to enable the arc to be struck with the smallest current to which the resistance B can be adjusted. A suitable choking coil for use with the usual sizes of iron electrodes requiring up to 200 ampères is composed of about 200 turns of copper strip wound on edge in the form of a helix, and having an inside diameter of about 8in., with an overall length of about 18in. In accordance with another scheme described, the choking coils are made so that they can be adjusted.—*December 29th*, 1927.

MISCELLANEOUS.

282,592. June 7th, 1927.—IMPROVEMENTS IN UPRIGHT INSULATORS FOR HIGH-TENSION ELECTRIC CURRENTS, Fritz Berg, of 13, Kepplerstrasse, Mannheim, Germany.

This invention relates to improvements in upright insulators used for insulating cables for the transmission of high-tension electric currents. It has been customary, the inventor states, in mounting upright insulators on their supporting arms or brackets simply to push the insulator, which was provided with a suitable boring for the purpose, on to an upright fixed to the mast arm or bracket support. This method of fixing does not in practice ensure sufficient rigidity, and a shaky loose connection



results, which is apt to lead to breakage of the porcelain or like insulator. According to the invention, the insulator is made of porcelain and is held in the conical seating A by any suitable metal B which is run in in the molten state. The upright fixing pin C is held in a bracket D in the ordinary manner by means of a nut. The upright is clamped in the bracket boss by means of the bolt E. The upright is provided with a collar which rests on the bracket boss. The seating boss F is provided with an internal thread which engages the external thread on the upright. The two parts are firmly screwed together and are prevented from slackening back by a split pin H.—*December 20th*, 1927.

282,573. February 22nd, 1927.—PRODUCTION OF WATER GAS AND HYDROGEN, Synthetic Ammonia and Nitrates, Ltd., Billingham, Stockton-on-Tees, Durham; and H. A. Humphrey.

The inventors start with a coal of preferably high caking properties, pre-heat that coal, preferably as a slack in the presence of oxygen so as to control its caking properties, and carbonise the product at a temperature not exceeding 600 deg. Cent. so as to produce a large proportion of lump semi-coke and finally treat said semi-coke with steam in a water gas generator. The lump semi-coke is gasified in a water gas generator by means of steam at a high temperature, and the resultant gas, containing undesirable fixed hydrocarbons, such as methane, derived from the semi-coke, is treated with steam at a high temperature to convert the methane, &c., to carbon monoxide and hydrogen. If desired, the semi-coke may be heated to a higher temperature —for example 800 deg. to 900 deg. Cent.—after low-temperature carbonisation, to drive off remaining volatile matter before treatment in the water gas generator. In this way a gaseous mixture comprising carbon monoxide and hydrogen in about equal proportions, and substantially free from methane, is obtained, and according to further features of the invention this gaseous mixture is utilised in any of the following ways:—(*a*) The gas mixture at atmospheric pressure may be passed in known manner over a catalyst favouring the production of higher paraffin hydrocarbons. Suitable temperatures for this reaction are from 200 deg. Cent. to 300 deg. Cent. Catalysts containing finely divided iron or metals, with or without promoters, may be used. (*b*) The original gas mixture or the residue from (*a*) after separation of the paraffins may be compressed and after removal of the methane, if present, passed over a catalyst such as basic zinc chromate favouring the production of methanol. (*c*) The original gas mixture or the single or combined residue from (*a*) and (*b*) may be treated with steam in the presence of an iron oxide catalyst at about 500 deg. Cent., in this way converting the carbon monoxide to carbon dioxide with the simultaneous production of hydrogen. The carbon dioxide is then removed, preferably by dissolution in water under pressure, and the residual hydrogen is mixed with the proper proportion of nitrogen for the synthesis of ammonia.—*December 29th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. "Casting," by Mr. J. B. Forster. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Honorary Member's Lecture, "Some Principles of Investigation in Engineering Work," by Professor H. P. Philpot. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. Lecture, "The Highlands of Switzerland," by Mr. A. Bailey. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Mining Institute, Newcastle-upon-Tyne. Paper, "Some Contributions to the Theory and Practice of Lubrication," by Mr. J. E. Southcombe. 6 p.m.

THE PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. The following papers will be read:—"A Simple Graphical Method for the Determination of Galvanometer and Fluxmeter Constants: with a Note on the Measurement of Intense Magnetic Fields," by Mr. Allan Ferguson and Dr. E. J. Irons, B.Sc.; "On a Method of Constructing the Caustic Curve Formed by Refraction at a Plane Surface," by Dr. C. J. Smith, Ph.D.; "The Application of Electrical Resistance Measurements to the Study of Atmospheric Corrosion of Metals," by Mr. J. C. Hudson. 5 p.m. Editing Committee Meeting at 3.45 p.m. Council Meeting at 4.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Research on the Control of Aeroplanes," by Professor B. Melvill Jones. 9 p.m.

SATURDAY, FEBRUARY 11TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Les Gobelins Restaurant, Heddon-street, Regent-street, London, W. 1. London Graduates' annual dinner and dance. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' afternoon visit to the Glengall Ironworks, Millwall.

MONDAY, FEBRUARY 13TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Further Notes on Aluminium Alloys," by Mr. D. R. Tullis. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Queen's Hotel, Birmingham. Paper, "Some Notes on Reorganising a Works to Increase Production," by Mr. C. R. F. Engelbach. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-on-Tyne. "Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Sub-stations," by Mr. H. B. Poynder. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lectures, "Fatigue Phenomena, with Special Reference to Single Crystals," by Dr. Herbert John Gough. 8 p.m.

TUESDAY, FEBRUARY 14TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Paper, "Semi-Steel," by Mr. Goodyer. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, London, E. 1. "Corrosion of Iron and Steel, with Special Reference to Steam Boilers," by Mr. Geo. S. Irving. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Paper, "Silencing," by Mr. L. H. Pomeroy. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Central Station Hotel, Newcastle-on-Tyne. Annual dinner. 7 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Causes of Fires in the Petroleum Industry and Methods of Prevention," by Mr. C. Dalley. 5.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—The Engineers' Club, Coventry-street, London, W. 1. Informal dinner and discussion on "Why the Aeroplane is Superior to the Seaplane in Imperial Communications," opened by Major R. H. Mayo. 7.30 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—In the Electrical Engineering Room, No. 149, The Royal Technical College, George-street, Glasgow, C. 1. "Modern Electric Wiring, Particularly as Applied to Small Houses," by Mr. D. S. Munro. 7.30 p.m.

TUESDAY AND WEDNESDAY, FEBRUARY 14TH AND 15TH.

SOCIETY OF GLASS TECHNOLOGY.—Tuesday, in Council Chamber, Western Bank, meeting of Refractories Committee. 5.45 p.m. Wednesday, in Room C. 4, the Applied Science Department, The University, St. George's-square, Sheffield. General meeting. "The Analysis of Opal Glasses," by Mr. W. Singleton; "The Study of a Fundamental Reaction in Glass Making," by Mr. J. T. Howarth and Professor W. E. S. Turner; "Note on the Ultra-Violet Ray Transmission of Colourless Bottle Glass," by Mr. David Starkie and Professor W. E. S. Turner. 2.30 p.m.

WEDNESDAY, FEBRUARY 15TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to the works of Tarmac, Ltd., Ettingshall, near Wolverhampton. 3 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Students' meeting. "New Training Bank at South Haven, Poole Harbour," by Mr. W. T. Shaddock. 6.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate section. "Floating Docks," by Mr. L. C. Burrill. 7.15 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, London, S.W., The following memoirs will be discussed:—"The Single-layer Problem in the Atmosphere and the Height-integral of Pressure" (*Memoirs*, Vol. I., No. 2, published 1926), by L. F. Richardson and R. E. Munday; "The Variance of Upper Wind and the Accumulation of Mass" (*Memoirs*, Vol. I., No. 4, published 1926), by L. F. Richardson, D. Proctor, and R. C. Smith; the following paper will be read:—"The Distribution Over the British Isles of the Average Number of Days with Rain during each Month of the Year," by Dr. John Glasspoole. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Trinity House, its History and its Work," by Captain Sir Arthur Wellesley Clarke. 8 p.m.

SOCIETY OF TECHNICAL ENGINEERS: LONDON BRANCH.—Engineers' Club, 39, Coventry-street, London, W. 1. "The Application to Engineering of the Dewey System of Decimal Classification," by Mr. R. Borlase Matthews. 7.45 p.m.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Holborn Restaurant (Caledonian Room), London, W.C. 1. Annual general meeting. Presidential address by Mr. S. Booth Horrocks. A dinner will take place after the meeting at the Holborn Restaurant, Queen's Room, at 6.30 for 7 p.m.

THURSDAY, FEBRUARY 16TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Papers: "Modern Electric Wiring, Particularly as Applied to Small Houses," by Mr. D. S. Munro; and "The Domestic Applications of Electricity," by Messrs. A. J. Milne and R. H. Rawll. Cinematograph film, "Voices Across the Sea." 6 p.m.

OPTICAL SOCIETY.—Imperial College of Science, South Kensington, London, S.W. 7. Papers: "An Investigation into the Beam from a Standard Lighthouse Lens," by Dr. W. M. Hampton; "The Absolute Hartmann Test," by Mr. R. Kingslake. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "Experiments on Model Airscrews at High Tip Speeds," by Mr. G. P. Douglas. 6.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "From Faraday's Note Books: The Colours of Gold," by Sir William Bragg. 5.15 p.m.

FRIDAY, FEBRUARY 17TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, London, E. 1. Annual general meeting. 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Annual general meeting. Paper "Waste Heat Recovery," by Major W. Gregson. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecture and technical film, "Oil Production," by Mr. St. John Plevins. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The University: Its Ideals and its Problems," by Rev. E. M. Walker. 9 p.m.

SATURDAY, FEBRUARY 18TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, London, E. 1. Junior Section social gathering and dance. 7.11 p.m.

MONDAY, FEBRUARY 20TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. Informal discussion on "The Relative Importance of Sales, Design, and Works Organisation in Engineering." 6.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Canton Lecture, "Fatigue Phenomena, with Special Reference to Single Crystals," by Dr. Herbert John Gough. 8 p.m.

THE RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Annual general meeting, followed by Presidential address. 7.30 p.m.

MONDAY TO FRIDAY, FEBRUARY 20TH TO MARCH 2ND.

BRITISH INDUSTRIES FAIR.—Castle Bromwich, Birmingham, and at the White City, London.

TUESDAY, FEBRUARY 21ST.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—At 39, Elmbank-crescent, Glasgow. "Fatigue of Metals: Some Effects of Cold Drawing on the Strength and Endurance of Mild Steel," by Dr. R. M. Brown. 7.30 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE, AND THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.—Joint meeting in the Freemasons' Hall, George-street, Edinburgh. Public lecture on "Rugby Radio Station," will be given by Mr. E. H. Shaughnessy, at 7.30 p.m.

FRIDAY, FEBRUARY 24TH.

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS.—Room D Central Hall, Westminster, London, S.W. 1. Lecture, "Admiralty Floating Docks," by Mr. S. V. Goodall. 5.30 p.m.

MONDAY, FEBRUARY 27TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Fatigue Phenomena, with Special Reference to Single Crystals," by Dr. Herbert John Gough. 8 p.m.

CALENDARS, DIARIES, &c.

BECCO ENGINEERING AND CHEMICAL COMPANY, Ltd., Fitzalan House, Arundel-street, Strand, W.C. 2.—Wall calendar with monthly tear-off sheets.

HACKBRIDGE ELECTRIC CONSTRUCTION COMPANY, Ltd., and the HEWITTIC ELECTRIC COMPANY, Ltd., Hersham, Walton-on-Thames, Surrey.—Desk blotter, diary and memorandum pad.

A. LEWIN CURTIS, Westmoor Laboratory, Chatteris, England.—Desk calendar with monthly cards.

MARTIN'S, Stamford, England.—Wall calendar with monthly tear-off slips.

EDWARD WOOD AND CO., Ltd., 81, Cannon-street, E.C. 4.—Pocket diary.